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Science Data Processing (SDP) Toolkit Requirements Specification for the ECS Project

January 14, 1994

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APPROVED BY

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Preface

This document is a modification of the Product Generation System (PGS) Toolkit Requirements Specification for the Earth Observing System Data Information System (EOSDIS) Core System (ECS) Project, October 29, 1993, (193–801–SD4–001). These modifications are based on suggested changes from Earth Observing System (EOS) instrument data processing teams, Earth Science Data and Information System (ESDIS) representatives and ECS architecture changes in the year since the original document's introduction.

Note the formal name of the PGS Toolkit has been changed to Science Data Processing (SDP) Toolkit to reflect current architectural and functional capabilities of the Toolkit. The Requirements retain the PGS acronym to provide tracebility. CH01

Note that several sections of the original Specification have been deleted:

Section 3. ECS Overview—The information in this section is now covered by DID 305.

Section 6. PGS Toolkit Specification—The section is now covered in "The SDP Toolkit Users Guide for the ECS Project", July, 1995.

Section 7. Proposed PGS Toolkit Delivery Schedule—This section is now obsolete, as the final toolkit delivery accompanies this document.

Appendix B. POSIX System Calls Usage Policy—This appendix is contained in "The SDP Toolkit Users Guide for the ECS Project", July, 1995.

Appendix C. Open Issues—These issues are two years old and have been resolved.

Appendix D. Disposition of Unused Requirements—These requirements are obsolete.

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1. Introduction

1.1 Identification

This ECS SDP Toolkit Requirements Specification is a deliverable document under the Earth Observing System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-60000). It is a modification to the PGS Toolkit Requirements Specification, October 1993. CH01

1.2 Scope

The ECS SDP Toolkit Requirements Specification defines the requirements for the ECS Science Data Processing (SDP) Toolkit. These requirements reflect the software built and delivered to ESDIS in the fifth Toolkit delivery (Toolkit 5) July 1995. CH01

1.3 Purpose and Objectives

This document is a requirement's specification of the ECS SDP Toolkit. The ECS science software developer will use the Toolkit to access the Planning and Data Processing (PDPS) environment and services. The required use of the Toolkit can be divided into three classes: CH01

System Mandatory — In the production environment, external calls from the science software, for system and resource accesses, file I/O requests, error message transaction, metadata formatting and geographic information database requests will be made through Toolkit calls. The use of these tools will be enforced through automatic checks at integration time at the DAAC's.

Science Mandatory — These are the parts of the Toolkit that are necessary to ensure that the products can be used in subsequent processing and in correlative studies involving more than one type of EOS product. These types of calls include geolocation, time conversions, and physical constants. The use of these tools is more difficult to verify using automated code checkers, but will be assessed at integration time using a combination of automated checks (for inclusion and exclusion) and manual code reviews.

Science Optional — Other useful services such as scientific and math library calls, will be provided by the Toolkit. The use of these services is optional, but is encouraged. Algorithm developers who use alternative solutions will be required to deliver the source code for the replacement services as part of the algorithm delivery.

The SDP Toolkit will serve to insulate science software from the PDPS architecture, and to provide a development environment that emulates critical DAAC PDPS functions. The Toolkit will help ensure code portability as the algorithm is ported from development hardware, through the DAAC system, and through potential hardware changes as the ECS matures. To do so effectively, the Toolkit will provide for limited access and control to system level resources, including processes, CH01
memory, and I/O capabilities. Where control of such resources is necessary (e.g., dynamic memory allocation), the Toolkit will provide a set of routines through which the application must obtain those services. This partitioning and layering of operating system services allows the Toolkit to work on behalf of the PDPS Scheduler in allocating, de–allocating, and making use of system–wide shared resources.

The Toolkit will also serve to minimize code development by providing common functionality required across the ECS community.

The requirements for much of the Toolkit software come from contacts with the scientific community, through science operations scenarios and requirements reviews. Our objective is to provide the science community with a list of tools that will aid in the science software development process.

The SDP Toolkit has been delivered in stages to the developers. The software contained in these deliveries represent a baseline that will satisfy the identified functional requirements. The baseline will be modified as additional functional requirements arise during the ECS program lifetime. CH01

The principal goal of this document is to present a compilation of Toolkit requirements. This compilation has resulted from an investigation of science software developers needs; their development environments; DAAC system design requirements; requirements imposed by instrument development and flight schedules; and instrument team usage of the Toolkit through the first four software deliveries. CH01

The requirements on the Toolkit that are listed in this document are traced to higher level parent requirements. In the case where no trace exists, disposition of that particular need will be accomplished through normal program "recommended requirements" gathering.

1.4 Status and Schedule

This document accompanies the final scheduled Toolkit delivery in July 1995. It reflects the functionality of the delivered software. It is expected that requirements for additional functionality will necessitate subsequent Toolkit deliveries. At this time, a delivery is tentatively scheduled for February 1996. CH01

1.5 Document Organization

The document is organized as follows:

Section 1	Introduction—Presents the scope and purpose of this document	
Section 2	Related Documentation—Provides a bibliography of reference documents for the PGS Toolkits organized by parent and applicable documents	
Section 3	ECS Overview (Deleted)	CH01
Section 4	Science Computing Facility (SCF) Toolkit and Development Environment	
Section 5	PGS SDP Toolkit Requirements	
Section 6	PGS Toolkit Specification	
Section 7	Proposed PGS Toolkit Delivery Schedule	
Appendix A	Requirements Status and Tool Mapping	
Appendix B	Requirements Traceability Matrix	
Appendix C	Open Issues (Deleted)	CH01
Appendix D	Disposition of Unused Requirements (Deleted)	CH01
Glossary	Glosary (Deleted)	CH01
Acronyms	Acronyms (Deleted)	CH01

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2. Related Documentation

2.1 Parent Documents

The parent document is the document from which this SDP Requirements Specification's scope and content are derived. CH01

	The PGS Toolkit Study Report, Version 1.9a, GSFC–ESDIS 5/6/93
	Proposal for EOSDIS Core System: Technical Proposal, 9/3/91, Hughes Team
423–41–02	Goddard Space Flight Center, Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System, 6/2/94 CH01
423–41–01	Goddard Space Flight Center, EOSDIS Core System Statement of Work, through CN–09, 8/31/94 CH01
423–41–03	EOSDIS Core System Contract Data Requirements Document, 6/2/94 CH01
NASA–STD–2100–91	NASA Software Documentation Standard Software Engineering Program, approved 7/29/91 CH01
101–101–MG1–001	Project Management Plan for the EOSDIS Core System, 7/93 CH01

2.2 Applicable Documents

The following documents are referenced within this SDP Requirements Specification, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume. CH01

	UARS Lessons Learned for EOS: Report 1—Design and Implementation, CSC document for NASA contract NAS5–31500
	NCSA HDF Calling Interfaces and Utilities, Version 3.2, March 1993
194–301–DV1–002	System Implementation Plan for the ECS Project, 6/94 CH01
193–205–SE1–001	Science User's Guide and Operations Procedure Handbook for the ECS Project 8/93 CH01

IEEE Std 1003.1:POSIX Part 1: System Application Program Interface (API)[CLanguage]

IEEE Std 1003.9:POSIX FORTRAN77 Language Interfaces, Part 1: Binding for System Application Program Interface [API]

Time Code Formats, CCSDS 301.0–B–2, April 1990, Consultative Committee for Space Data Systems, Washington DC

Getting Started With HDF, U of Illinois, 1993, also available via anonymous file transfer protocol (ftp) from ftp.ncsa.uiuc.edu (141.142.20.50).

3. ECS Overview (Deleted)

CH01

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4. Science Computing Facility (SCF) Toolkit and Development Environment

4.1 Purpose

The purpose of the SCF development environment and toolkit is (1) to provide development toolkit functions that emulate the production toolkit functions, (2) to provide a development environment that emulates the production environment to support development and test, (3) make both functions
and environment easy to use, and (4) most importantly, allow for a smooth transition of science software from the SCF to the PDPS, during the integration and test phase. All SDP Toolkit routines will be provided to EOS science software developers in SCF versions. CH01

It is essential to understand the concepts that distinguish the SCF development environment from the PDPS production environment. While the science software and interface to the SDP Toolkit are preserved in both environments, there may be slightly different implementations and behavior in the toolkit functions and peripheral components (e.g., shell level development and testing tools). This section highlights the functionality of the SDP Toolkit that is especially significant to the SCF. The version of the SDP Toolkit that encapsulates that functionality shall, for the purpose of this document, be referred to as the SCF Toolkit. CH01

Note that the requirements listed below are not associated with specific Toolkit routines, but nonetheless serve to detail the overriding requirements that are mandated by the SCF environment.

Refer to Section 5 of this document for requirements for specific toolkit functionality that will be used in the production and development environments. CH01

4.2 Requirements

4.2.1 General

Requirement:

PGSTK–0020 Calling sequences of SCF Toolkit functions and SDP Toolkit functions shall be identical. CH01

Note:

In order for toolkit routines to be integrated into both the development and the production versions of the science software, the actual physical calling sequence in the code must be exactly the same in both versions. Note that there may be differences in the usage of the parameters passed to the functions; this is discussed elsewhere in this section.

Requirement:

PGSTK–0010 The interfaces provided by the SCF Toolkit functions to the science software shall either be identical to the interfaces provided by the SDP Toolkit functions to the science software, or they will be transparent emulations. CH01

Note:

Interfaces to the Toolkit include such items as the scheduling system, the communications system, and the computer operating system. Interfaces such as those to the communications system will need to be emulated. Interfaces such as those with the computer operating system will be identical.

Requirement:

PGSTK–0040 Logical file paths referenced by SCF Toolkit functions and SDP Toolkit functions shall be identical, i.e., all file references shall be by logical file names. CH01

Note:

In order to make a transition between the SCF development environment and the PDPS production environment easier, file names will be represented by logical identifiers, i.e., by UNIX environment variables. (The means of translating the logical values may differ between the two environments.) This requirement also makes it easier to assure that files shared among different executables in the SCF environment are accessed in a consistent manner. CH01

4.2.2 Tool Categories

Requirements:

PGSTK–0050 The SCF Toolkit shall provide the capability to run a production process in the SCF test environment.

PGSTK–0060 The SCF Environment shall provide the capability for science software developers to generate a production script, capable of linking multiple Product Generation Executive (formerly Product Generation Executable) (PGEs) into a single SCF command.

Note:

A production process may consist of several PGEs run consecutively. The capability to execute such a process from end–to–end will exist at the SCF, through the use of a production script and emulated PDPS services. CH01

Requirement:

PGSTK–0080 The SCF Toolkit shall provide the capability to test all I/O transactions among PGEs that originate in the science software, in the same manner as the production environment.

Note:

As is true of all toolkit functions, input and output function calls in the SCF science software will have the same calling sequences as functions used in the science software at the PDPS. The actual physical file locations may be different; for example, instead of a filename in the PDPS software that points to a remote location such as another DAAC; the filename will point to a local directory at the SCF. The differences in this case are to be handled by some mechanism, i.e., via UNIX environment variables, and so are transparent to the science software. Thus the I/O transaction itself is still being tested as if it is in the production environment. CH01

This means that all SCF I/O interfaces must be identical to the PDPS interfaces. The requirement specifically excludes any interaction with the scheduling sub–system, addressed elsewhere in this section. (Section 5.2.1 lists requirements for file I/O tools in the PDPS.) CH01

Requirement:

PGSTK–0090 The SCF Toolkit shall contain error/status handling and reporting capabilities identical to those available in the SDP Toolkit. CH01

Note:

Another important consideration is to have error and status reporting functions that transition smoothly between the development and production environments. Differences may occur in the destination of error messages; for example, at the PDPS these would be sent to the SCF over the net, whereas at the SCF they may simply go to a file. Again, neither the function calling sequences nor the arguments will change. This case may also be handled using UNIX environment variables. In cases where it may be necessary to change internal Toolkit code of error and status reporting functions, these changes will be transparent to the user. CH01

It is important that the meaning of error messages be the same in both development and production environment so that causes can be more readily determined.

This requirement implies that the interfaces between these functions and the environment must be identical at both the SCF and the PDPS. (Section 5.2.2 lists requirements for error handling in the PGS.) CH01

4.2.3 Code and Hardware

Requirement:

PGSTK–0100 The SCF Toolkit shall contain versions that have been certified for each of the ECS approved computing platforms.

PGSTK–0101 The SCF Toolkit shall exhibit its portability and adaptability by producing the same results (to an agreed upon tolerance) on each of the approved computing platforms. CH01

Notes:

The current community agreed upon platforms supported by the toolkit include:

Sun SPARC 10
Sun OS
HP 9000/735
SGI IRIX
DEC Alpha
IBM RS 6000
Cray C90
SGI Power Challenge CH01

Based on interviews with the science teams regarding anticipated development platforms, the following candidate platforms have been identified for initial Toolkit testing and integration:

Highest priority (specific development plans): Sun Sparc 10 (Solaris) and SGI R4000 and R4400 (IRIX).

Additional machines will be selected from DEC, HP, and IBM workstation families as a test suite. A Cray Y/MP EL will be used for initial large supercomputer testing.

This is a baseline test suite that will be modified in subsequent versions of Toolkit Releases. In so far as the developer understands that the initial Toolkit will be released and tested for these specific platforms only, the developer may link the Toolkit software on any related platform that the he/she believes to be compatible.

Requirement:

PGSTK–0123 SCF Toolkit source code shall be delivered to the SCFs.

Notes:

Access to toolkit source code is essential to science software developers so that they may debug their own and toolkit software, without having to wait for turnaround at the PDPS for toolkit updates. However, developers must be made aware that their code must use the official version of the toolkit software in order to run at the PDPS. The DAAC staff will not manage tool software that has been changed at the SCF. CH01

4.2.4 Data Access

Requirement:

PGSTK–0140 The SCF Toolkit shall provide access to Level 0 data provided by science software developers and/or ESDIS.

PGSTK–0141 The SCF Toolkit shall provide access to simulated orbit data for at least 1 day and 1 night (15 consecutive orbits).

Notes:

The heart of simulated data in the development environment is the Level 0 data. Such data and/or the tools that generate it will be provided by ESDIS, e.g., the orbit/attitude data may come from the Flight Dynamics Facility, while the science data may be provided by the science software developers themselves.

Science test data formats, which are not addressed by this requirement, are assumed to be identical at both the PDPS and the SCF; this is to avoid problems at DAAC integration time. CH01

4.2.5 Support and Documentation

Requirement:

PGSTK–0160 The ECS contractor shall provide an Algorithm Integration Team at each DAAC, whose function shall be to answer questions about the SCF and SDP Toolkits, PDPS design and operations concept, and the science software integration and test process. CH01

Notes:

Ongoing communication between ECS contractor personnel and science software developers is crucial to the success of the SCF development effort, and hence the PDPS as a whole; the Algorithm Integration Team exists as a bridge between the two groups. CH01

Requirement:

PGSTK–0170 A detailed user's guide for the SCF Toolkit shall be delivered, in both hardcopy and electronic versions, and shall include at a minimum detailed descriptions of the SDP Toolkit; all differences between the SCF and PDPS versions, both visible and invisible to Toolkit users, a set of sample production shell scripts; and sample makefiles. CH01

4.3 SCF and PDPS Environmental Comparison

This section describes the SCF development environment and lists the differences between it and the PDPS production environment.

4.3.1 Overview

The details of the PDPS environment include how the planner, scheduler and toolkit functions all interact with each other, as described in Section 3 of this document. The implementation of these components in the SCF environment is somewhat different. CH01

4.3.2 Planner

PDPS —The Planner runs once per day, assembling a list of PGEs to execute based on their priority, along with their file inputs and outputs, and associated resource dependencies; it essentially plans daily activity based on predicted data availability. (See Section 4.3.5 for further details of PDPS Planner capabilities.) CH01

SCF—The Planner is not emulated. Since the Planner creates a tentative list of activities that are data driven, the functionality added to the SCF test process would be minimal. Testing of the planning process is best done at integration and test time at the PDPS. CH01

4.3.3 Scheduler

PDPS —The Execution Monitor runs in real time; its functions include staging files, monitoring data availability and time constraints, and error handling. It also initiates PGE execution based on data availability, metadata query constraints (such as Q/A flags), computer resources, and priorities.

SCF—The Scheduler will not be part of this environment. Instead, its capabilities will be emulated by the execution of production scripts, which are tailored by the developers for the specific requirements of their science software.

4.3.4 Toolkit functions

PDPS—These functions, designed for production, are described in Section 6. CH01

SCF—Higher level functions such as math/stat functions and geolocation functions will be identical to the PGS functions. Some lower level functions may have slightly different action, such as error status output, which may be directed to a local file instead of a remote destination, for example. There may also be differences with the PDPS version that are transparent to the SCF user. These differences must be kept to an absolute minimum in order to assure smooth integration of science algorithms at the PDPS. CH01

In Table 4–1 we show a comparison between the SCF development environment and the PDPS production environment.

Table 4–1. A Comparison of SCF and PDPS Functionality CH01

Environment Attributes	SCF Development	PDPS Production
Resource management	manual	planner
Product generation	production script(s)	scheduler
Execution criteria	associated table	product orders database/TBD
system resources	identical	
PGE priorities	single PGE	multiple PGEs
metadata constraints	identical	
time thresholds	identical	
data dependencies	identical	
Product strings	single string	multiple strings
Data formats	identical	
File management		
logical locations	mapped by developer	mapped by scheduler
staging	manual/production–script	scheduler
Toolkit		
access to level 0 data	simulated (pre–launch)	simulated (pre–launch)
	actual (post–launch)	actual (post–launch)
access to orbit data	simulated (pre–launch)	simulated (pre–launch)
	actual (post–launch)	actual (post–launch)
error/status reporting	local destination	network destination
termination status	handled by production script	handled by scheduler
I/O interactions	identical	
other tools	identical	
calling sequences	identical	

4.3.5 Other Development Tools

For a discussion of other software development tools such as CASE tools, code checkers, static and dynamic analyzers, and memory monitors, see *Science Users' Guide and Operations Procedure Handbook for the ECS Project* [DID 193–205–SE1–001], Section 4.1.

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5. SDP Toolkit Requirements CH01

5.1 Introduction

5.2 SDP Toolkit Requirements—System CH01

In this section, we list requirements derived from the Level 3 requirements in Section 4.1.

The following three requirements apply to many tools in Section 4.

PGSTK–0180 All SDP Toolkit functions shall return error/status codes that can be detected and reported using error/status reporting tools.

PGSTK–0120 The SCF version of the SDP Toolkit shall be POSIX compliant.

Explanation**:** The Toolkit will conform to the POSIX standard to the extent that the standard is supported by vendors of ECS approved platforms. CH01

PGSTK–0121 The SDP Toolkit shall provide bindings to ECS approved languages.

Note**:** The current list of ECS approved languages includes C, FORTRAN77 and FORTRAN90 ADA (users are required to supply toolkit bindings). Support of other languages, such as C++ will be supported upon approval of the ESDIS Project.

PGSTK–0122 The SDP Toolkit shall be supported under the following UNIX shells: Bourne, csh and the Perl language.

5.2.1 File I/O Tools

5.2.1.1 Level 0 Science Data Access

PGSTK–0190 The SDP Toolkit shall contain tools to open and close Science Data Processing Facility (SDPF), EOS Data and Operations System (EDOS)–generated Level 0 data sets or data sets from other sources as determined by the ESDIS Project.

Note**:** EDOS formats are not available at the time of Toolkit 5. CH01

PGSTK–0200 The SDP Toolkit shall contain tools to read Consultative Committee on Space Data Systems (CCSDS)–format packetized data from Level 0 data files. Data is assumed to be made available to the Toolkit in the native format of the computing platform the Toolkit is instantiated on.

PGSTK-0210 (Deleted)

Explanation**:** subsumed by PGSTK–0200 and PGSTK–0230

PGSTK–0220	The SDP Toolkit shall include the capability to provide the first CCSDS packet after a given time.	CH01
PGSTK–0230	The SDP Toolkit shall contain tools to access the metadata located within Level 0 data files , (e.g., SDPF– and EDOS–generated header, accounting and quality information).	
Note**:**	EDOS formats are not available at the time of Toolkit 5.	
PGSTK–0235	The SDP Toolkit shall contain tools to access the ECS–internal metadata that is associated with the Level 0 data files provided to a PGE.	
Note**:**	This is satisfied by the MET tool PGS_MET_GetPCAttr.	
PGSTK–0240	The SDP Toolkit shall provide tools to access SDPF–, EDOS–provided telemetry data, or access to data sets from other sources as determined by the ESDIS Project.	
Note**:**	This is met by all Level 0 requirements.	
Note**:**	EDOS formats are not available at the time of Toolkit 5.	CH01

5.2.1.2 Hierarchical Data Format (HDF) File Access

PGSTK–0271	The SDP Toolkit shall contain tools that list the contents of HDF files, and verify that the files are legal HDF files.	
Note**:**	Met by National Center for Supercomputer Applications (NCSA) HDF library—will be met by HDF–EOS.	
PGSTK–0270	The SDP Toolkit shall contain tools that select data items within an HDF file, and read the selected data item, and optionally rewrite the HDF file with changes made to the data item.	
PGSTK–0290	The SDP toolkit shall contain tools that read from and write to metadata information contained in HDF files.	
Explanation**:**	No update capacity is needed in the DAAC environment. This is covered by a Data Server requirement.	
PGSTK-0320	(Deleted)	CH01
Explanation**:**	Subsumed by 0321.	
PGSTK–0321	The SDP toolkit shall contain tools to read from and write to HDF files.	CH01
Explanation**:**	This requirement is too general.	
PGSTK-0323	(Deleted)	CH01
Explanation**:**	This requirement is too general. RLE and JPEG compression are provided for user choice.	

PGSTK–0324 The SDP toolkit shall contain tools to convert a single instance of selected HDF datatypes into files in formats identified by the ESDIS project. CH01

Note**:** An example would be converting an HDF raster image into a FITS image file. Note that only certain components of an HDF file would be converted: in general it would be impossible to transfer the complex internal organization of HDF files completely into alternate formats.

5.2.1.3 Generic File Access

PGSTK–0360 The SDP Toolkit shall contain tools to open and close generic files, including text and binary files. These generic files will be limited to those produced by an ECS approved language.

5.2.1.4 Metadata

PGSTK–0370 The SDP Toolkit shall support opening a metadata file.

PGSTK–0380 The SDP Toolkit shall be able to read information from and write information to a metadata file containing standard product and science–software–specific information. This software specific information will include program version number; institutional source; and other identifying information approved by the ECS Project.

PGSTK-0390 (Deleted) CH01

Explanation**:** Unnecessary requirement, access is via keywords and by covered in PGSTK–0400. CH01

PGSTK–0400 The SDP Toolkit shall be able to write a record of metadata in the metadata file using ECS standard structuring, and contain ECS standard, instrument specific and product specific attributes. The record will contain program variables and constants as well as values generated automatically (e.g., configuration information).

PGSTK–0410 The SDP Toolkit shall be able to overwrite a record in the temporary metadata store during PGE execution with a new record.

PGSTK-0411 (Deleted)

Explanation**:** The SDP MET tools operate only within the PDPS environment. Adding new parameters to an existing record is largely a data server/inventory function. However, the MET tools do provide the capacity to add new parameters into standard product files.

PGSTK-0440 (Deleted)

Explanation**:**	Unnecessary requirement, access is via keywords and by covered in PGSTK–0400.	
PGSTK–0430	The SDP Toolkit shall support closing a metadata file.	
PGSTK–0450	The SDP Toolkit shall support writing the ECS standard, instrument specific and product specific attributes into an ECS standard product file.	

5.2.1.5 Data Quality Assurance

PGSTK–0510	The SDP Toolkit shall contain tools that support three types of Q/A data: (1) flags; (2) graphics files, which are output directly from science processes; and (3) data that is written in the same format as a standard product file.	CH01
Note**:**	These are covered by other requirements.	

5.2.1.6 Temporary Files

PGSTK–0520	(Deleted)	
Explanation**:**	Actual deletion of unmarked temporary files is done automatically at PGE termination. No action is necessary by the science software, so no tool is required for this purpose.	
PGSTK–0521	The SDP Toolkit shall contain a command tool for marking temporary files for deletion, enabling reuse of the logical file ID within the science software, while preserving the record of the defunct temporary file.	
PGSTK–0530	The SDP Toolkit shall create temporary file names such that each name is unique for a given DAAC.	
PGSTK–0531	SDP Toolkit shall contain a tool for creating "intermediate" files, whose longevity is determined by the user up to ECS defined limits, e.g., a temporary calibration file may be retained as an intermediate file from the last orbit's processing or a file kept for averaging purposes for several months.	CH01
PGSTK-0532	(Deleted)	CH01
Explanation**:**	This is a PDPS requirement.	
PGSTK-0533	(Deleted)	CH01
Explanation**:**	This requirement is covered by PGSTK–0531.	
PGSTK-0534	(Deleted)	CH01
Explanation**:**	This requirement is covered by PGSTK–0531.	
PGSTK–0535	The SDP Toolkit shall contain command tools for creating and retrieving intermediate and temporary file reference names at the level of the PGE's script.	

PGSTK-0540 (Deleted)

Explanation**:** This is a PDPS function. Since there are no longer any tools that the science software can use to delete temporary files, this requirement is unnecessary.

5.2.1.7 Miscellaneous I/O

PGSTK-0550 (Deleted) CH01

Explanation**:** This is not a Toolkit requirement; it is covered by data server and/or PDPS requirements.

PGSTK–0570 The SDP Toolkit shall contain tools to monitor for the presence of the quicklook flag, which indicates that transmission to the SCF of part of the data from the spacecraft or from Level 1, is required. CH01

Explanation**:** There is no difference between regular and quicklook data to the Toolkit. Science software is responsible for reading in and writing out L0 data in such a manner as it sees fit, to create quicklook data.

PGSTK-0310 (Deleted) CH01

Explanation**:** This is not a Toolkit requirement; it is covered by data server requirements.

5.2.2 Error/Status Reporting

Requirement:

PGSTK–0580 The SDP Toolkit shall contain tools that can test for multi–level error/status conditions.

PGSTK–0581 The SDP Toolkit shall provide an ordering for the multi–level error/status conditions thus enabling them to be used in conditional expressions.

PGSTK–0582 The SDP Toolkit shall contain tools that allow the user to assert an error/status condition with a discrete severity level.

PGSTK–0590 The SDP Toolkit shall support the following levels for error/status conditions: fatal error, general error, warning error, notice status, user–defined status, informational message status and success status.

PGSTK–0591 The SDP Toolkit shall provide the means of associating an action message with one or more status conditions.

PGSTK–0600 The SDP Toolkit shall contain tools for recording user and Toolkit–defined error and status reports to log files. CH01

PGSTK–0610 The SDP Toolkit shall contain tools to uniquely identify the software unit, science software program, product and production run in error and status messages.

PGSTK–0620	The SDP Toolkit shall contain tools to identify the associated instrument within the error message codes.	
PGSTK–0630	The SDP Toolkit shall provide a tool for marking all user requested files and status logs for subsequent retrieval by the SCF.	
PGSTK–0631	The SDP Toolkit shall support a tool for transferring all report and status logs to an intermediate location.	
Note**:**	This is strictly an SCF function; the means to effect this transfer will be disabled for the DAAC version of the Toolkit.	
PGSTK–0632	The SDP Toolkit shall contain tools for integrating Commercial–off–the–Shelf (COTS) status messages into the Toolkit wherever the Toolkit uses that COTS software.	CH01
PGSTK–0650	The SDP Toolkit shall contain tools to associate with error messages at least the following: what routine noted the error, error–type, pertinent variable data, and action taken.	
PGSTK–0660	The SDP Toolkit shall contain tools to allow science algorithms to enable error trapping mechanisms for non–processing relating signals, and to issue the appropriate signal handling routines to respond to these events.	CH01
PGSTK–0661	The SDP Toolkit shall be capable of performing context–sensitive buffering of status message information in order to provide an optimal level of efficiency.	
PGSTK–0662	The SDP Toolkit shall prevent the proliferation of duplicate status messages from being recorded in the status log files.	CH01
PGSTK–0663	The SDP Toolkit shall provide the tools to enable and disable status messaging for user–specified calls.	
Note**:**	This will be accomplished by using the PGS_SMF_Begin & PGS_SMF_End calls.	
PGSTK–0664	The SDP Toolkit shall provide the tools to ensure that user status codes are unique across the entire ECS system.	
Note**:**	This is accomplished with smfcompile.	

5.2.3 Process Control

PGSTK–1280	The SDP Toolkit shall provide tools to generate product identifiers that can be used by the script/PGE to label metadata with environment and PGE information in order to facilitate production tracking.	CH01
PGSTK–1290	The SDP Toolkit shall provide tools to deliver runtime parameter data to the PGE.	

Note: Examples of these parameters may include: executable mode values, availability of alternate data files, product output subset identification, filename references, number of staged versions, number of physical files associated with a file logical, and system defined directory paths for all PGE file inputs and outputs.

PGSTK–1291 The SDP Toolkit shall provide command tools to deliver runtime parameter data to the PGE's shell. CH01

Note: Examples of these parameters may include: executable mode values, availability of alternate data files and system defined directory paths for temporary files.

Explanation**:** This is derived from PGSTK–1290.

PGSTK–1310 The SDP Toolkit shall provide tools for retrieving file metadata (also known as file attributes) that is associated with files staged by the Data Processing Subsystem.

PGSTK–1311 The SDP Toolkit shall provide tools for performing PGE initialization and termination procedures to support PGE usage of the Toolkit.

PGSTK–1312 The SDP Toolkit shall provide a command tool to facilitate the execution of a PGE and its' initialization and termination. CH01

PGSTK–1313 The SDP Toolkit shall provide a command tool to perform format checking on files containing Process Control information.

PGSTK–1314 The SDP Toolkit shall provide a command tool for retrieving file metadata that is associated with files staged by the Data Processing Subsystem.

PGSTK–1315 The SDP Toolkit shall provide a command tool to retrieve the number of physical file instances that are associated with a single logical file instance.

5.2.4 Memory Management

PGSTK–1240 The SDP Toolkit shall provide tools which (1) dynamically allocate process–private memory (perhaps with limits) and (2) explicitly free dynamic memory within a program when it is no longer needed. CH01

PGSTK–1241 The SDP Toolkit shall provide tools which (1) allow a PGE to create a shared memory segment and (2) provide the means for applications within the PGE to access that shared memory segment for the duration of the PGE's execution. CH01

5.2.5 Bit and Byte Manipulation

PGSTK–1600 The SDP Toolkit shall provide tools that perform bit and byte manipulation directly from applications developed in Fortran77. CH01

Explanation**:** This functionality is already provided by the MIL–STD 1753 extensions to ANSI Fortran77, and is known to be widely available.

5.2.6 Ancillary Data Access and Manipulation

Note**:** Ancillary data refers to any data, other than Standard Products, that are required as input in the generation of a Standard Product. This may include selected engineering data from the EOS platform, as well as non–EOS ancillary data. All ancillary data is received by the PGS from the DADS.

PGSTK–1360 The SDP Toolkit shall provide access to ancillary data sets used by several instrument processing systems. CH01

Explanation**:** The overall philosophy for these tools is to provide common software interfaces to ancillary data. Many ancillary data sets are instrument specific in terms of format and access pattern. Developing such tools centrally would be pointless given the expertise in the instrument teams.

PGSTK–1362 The SDP toolkit shall provide interfaces to access, retrieve and selectively manipulate ancillary data sets as required by the ESDIS Project. CH01

Explanation**:** The previous wording implied manipulations of a subset of data sets whereas the philosophy of the toolkit is to provide general functionality to all commonly used data sets; hence the change in wording.

PGSTK–1361 (DELETED) CH01

Explanation**:** This information is available through the MET tools. (PGSTK 0380)

5.2.6.1 Dynamic Ancillary Data from Internal Sources

Note**:** Dynamic data sets are those containing parameters whose values change routinely and predictably; i.e., at set intervals in time. Internal sources are those within the EOSDIS and therefore have EOSDIS controlled interfaces.

PGSTK–1363 (DELETED)

PGSTK–1364 (DELETED) CH01

PGSTK–0730 (DELETED)

PGSTK–1366 (DELETED)

Explanation**:** This is mostly instrument specific engineering data access. General access provided is through Level 0 API. We do not have the definition of the engineering data stream at the time of Toolkit 5. We cannot implement this tool until we have the definition.

PGSTK–1251 (DELETED) CH01

Explanation**:** This is covered by HDF requirements.

5.2.6.2 Static Ancillary Data from Internal Sources

Note**:** Static data sets are those containing parameters whose values may change, but not routinely or at set intervals in time.

PGSTK–1265 (DELETED) CH01

Explanation**:** This requirement is partially covered by HDF requirements. Providing access to ASCII files provided by instrument teams is provided by the GEN_IO requirements. Providing access to specified parameters is only possible when ASCII PVL format is used (PGSTK–1365).

PGSTK–1365 The SDP toolkit shall provide an interface that accepts simple searches for parameter values on a PARAMETER=VALUE basis and returns parameter values. CH01

5.2.6.3 Static Ancillary Data from External Sources CH01

Note**:** External sources are those providing data in formats and via interfaces not directly controlled by the EOSDIS project.

PGSTK–0840 The SDP Toolkit shall provide a means to retrieve requested physical and geophysical parameters at specified locations from a selected data set. Data sets shall be those required by the ESDIS Project but will include as a minimum a Digital Elevation Model (DEM) and a land–sea mask. CH01

Explanation**:** The toolkit does provide a means to retrieve geoid values where the geoid has been created in a raster binary format similar to that commonly used by DEMs. However, the geoid data set was deleted from this requirement since there is no such geoid data set available and creation of data sets is not covered by these requirements.

PGSTK–0850 The SDP Toolkit shall provide a means to retrieve regular grids or volumes of the required parameter defined by the upper left and bottom right vertices (x,y,z at each vertex). CH01

Explanation**:** The Toolkit supports this type of extraction by structure (x,y,z in cell number terms). The last part of the requirement is unclear. If it implies extraction by geographic coordinates then this is not supported (and is very undesirable to perform); otherwise it is a meaningless addendum.

PGSTK–0870 The SDP Toolkit shall contain tools to access a land/sea classification database including coastal outlines. CH01

PGSTK–0980 The SDP Toolkit shall provide a means to retrieve elevation and terrain information from various terrain models at a specified latitude and longitude coordinate.

Explanation**:** There is no known DEM having slope and aspect as pre–generated parameters. Generation 'on–the–fly' is undesirable and requires commonly agreed interpolation rules that are not available at this time. This information can be derived from the DEM access tool (PGSTK–0840).

PGSTK–1000 The SDP Toolkit shall provide a means to receive from various terrain models a regular grid of elevation from a rectangular area defined by the maximum extent of the rectangle. CH01

Explanation**:**	There is no known DEM having slope and aspect as pre–generated parameters. Generation 'on–the–fly' is undesirable and requires commonly agreed interpolation rules that are not available at this time.	
PGSTK–1030	The SDP Toolkit shall provide the functionality to retrieve elevation and related information from DEMs (e.g. error terms, variability of elevation) as available.	CH01
Explanation**:**	There is no known DEM having one–sigma parameters. ECS can only supply with toolkits those datasets that are immediately available.	
PGSTK–1040	(DELETED)	CH01
Explanation**:**	This is single instrument specific (required by Moderate–Resolution Imaging Spectroradiometer (MODIS) only).	
PGSTK–1070	The PGS Toolkit shall provide the geoid to ellipsoid difference at a specific latitude/longitude coordinate.	
PGSTK–1071	(DELETED)	CH01
Explanation**:**	The generic 2D tools provided in the toolkit could be used to access such a data set if, a) one was available b), it was in simple binary format. However, neither of these is known to be true. In addition, the data set is required by a single instrument (MODIS).	
PGSTK–1072	The SDP Toolkit shall provide tools to access images, where an API already exists.	CH01
Explanation**:**	This is single instrument specific and could be covered by generic 2D tools.	
PGSTK–1073	(DELETED)	CH01
Explanation**:**	This is covered largely by land/sea tool (PGSTK–0840) while the 95% sea/ice part may or may not be realizable from National Environmental Satellite Data and Information Service (NESDIS) products. Sea ice products will be sought out from NESDIS but ECS cannot say what the percentile coverage is or develop special data sets to service this requirement.	

5.2.6.4 Dynamic Ancillary Data from External Sources

PGSTK–0931	The Toolkit shall provide access to physical and geophysical datasets to retrieve single or multiple parameters and values from requested points, areas or volumes.This will include National Meteorological Center (NMC) six hour global model temperature, moisture and ozone profiles; NMC six hour global model surface parameters; and weekly Special Sensor for Microwave Imaging (SSM/I) snow and ice data from NESDIS.	CH01
Note**:**	It is assumed that these data sets are already in a structured format.	

Explanation**:** This requirement was updated following a review with EOS instrument team representatives on Jan. 31, 1995. The specific data sets are those commonly required (analysis from ECS SO). This requirement cannot be finally met until pre–processing software is in place and the HDF–EOS development is complete (including geo access tools). Current tools will provide this type of access provided pre–processing to simple binary is performed.

PGSTK–1074 (DELETED) CH01

Explanation**:** Subsumed by PGSTK–0931 This requirement is written unclearly.

PGSTK–1370 The SDP Toolkit shall provide an interface to perform simple linear interpolation in tspace between ancillary parameter points in geographically gridded data sets such as those in the NMC set. CH01

Explanation: Interpolation in time is a highly complex function requiring knowledge within the proposed tool of the metadata content—this is not currently available. Interpolation is generally provided by PGSTK–1245.

The following requirements are a subset of the full set for Tropical Rainfall Measuring Mission (TRMM) instruments:

PGSTK–1075 (DELETED) CH01

Explanation**:** This requirement is instrument specific from Lightening Imaging Sensor (LIS) and LIS no longer appears to require any ancillary data. LIS AHWGP v2.1/CDR Tech Baseline makes no reference for any use of tropopause model data in routine processing.Only required inputs for LIS are: Level 0 data (& ephemeris); LIS–team supplied ASCII file w/ parameters that set degree of processing at one step; LIS–team supplied calibration lookup table files.

PGSTK–1076 (DELETED) CH01

Explanation**:** This explanation is subsumed into PGSTK–0931 and single instrument specific.

PGSTK–1077 (DELETED) CH01

Explanation**:** This explanation is subsumed by PGSTK–0931 and single instrument specific.

The following are a subset of requirements for instruments on other platforms.

Requirement:

PGSTK–1078 (DELETED) CH01

Explanation**:** The latter 3 sources are single instrument specific (AIRS) and should be deleted. The first will be subsumed in PGSTK–0931.

PGSTK–1079 (DELETED) CH01

Explanation**:** This requirement is from instruments not on the TRMM or EOS–AM platforms. In addition, the definition of a standard tidal algorithm is unlikely to be possible during 1995. We cannot, therefore, meet this requirement for TK5.

PGSTK–1081 (DELETED) CH01

Explanation**:** Subsumed in PGSTK–0931.

PGSTK–1082 (DELETED) CH01

Explanation**:** ECS cannot guarantee period of data since it relies on ADC product operation. This requirement is also covered generally by PGSTK-1081.

5.2.7 Spacecraft Ephemeris & Attitude Data Access

PGSTK–0680 Input to all relevant SDP Toolkit planetary body and spacecraft position access functions shall include spacecraft identification.

PGSTK–0710 The SDP Toolkit shall use a single standard internal time in all ephemeris calculations. CH01

PGSTK–0720 The SDP Toolkit shall provide tools to return spacecraft position, velocity, attitude, and quaternion defining the rotation from spacecraft to Earth Centered Inertial reference frame for any given time or for a range of times, including provision for interpolation between state vectors.

PGSTK–0740 SDP Toolkit shall have the capability to provide to the user quality information about position and attitude.

Explanation**:** We do not expect to have sufficient information to meet the original requirement. It may be almost impossible to actually have a user specify an accuracy and the toolkit guarantee that what is returned has that accuracy. It would also mean changing calling sequences.

CH01

5.2.8 Time and Date Conversion

PGSTK–1170 The SDP Toolkit shall provide tools to transform time among the six following systems:

a. Coordinated Universal Time (UTC) (Date and ASCII formats)

b. UT1 (binary and Julian Date formats) CH01

c. International Atomic Time (TAI) (binary and Julian Date formats)

d. Julian Date (floating point format, in units of days)

e. spacecraft clock

f. Global Positioning System (GPS)

Note**:** In all case a, the ASCII format shall be, at the option of the user, CODE A or CODE B of *TIME CODE FORMATS,* CCSDS 301.0–B–2, April 1990.

Explanation**:** Civil time, which is useful for labeling events and for user recognition, is always related directly to UTC. There is no use for other times in ASCII, and confusion could result. Julian dates are always used as days and fraction of day from 4713 BC.

Explanation**:** (c) UT2 is not much used any more It is an approximate prediction of Earth motion.

Note: Julian Date (a) and (c) functions are provided with the toolkit, but do not appear as a users guide entry.

PGSTK–1215 The SDP Toolkit shall contain tools to convert UTC to UT1 and ephemeris times. CH01

Explanation**:** PGSTK–1215 is meaningless—Julian dates are always from 4713 BC. UTC and UT1 have no epoch base. They are always in days and never in seconds. UT2 is not much used any more. It is an approximate prediction of Earth motion.

PGSTK–1220 The SDP Toolkit shall contain provision to transform UTC and TAI to and from Julian Day formats, and to provide UT1 as a Julian Date, as well as a difference from UTC.

Explanation**:** PGSTK–1220 is meaningless—Julian dates are always from 4713 BC.

Note: Functions to compute UT1–UTC and Julian Day formats for UTC and TAI are included with the toolkit, but do not appear as a users guide entry.

Fulfilled by PGSTK–1170. CH01

PGSTK–1160 The SDP Toolkit shall contain time system transformation tools that return UTC and TAI (International Atomic Time) times and Julian Dates that are of the same precision as the spacecraft clock.

Note**:** This requirement subsumes several requirements regarding time accuracy at the millisecond level received from the instrument teams.

PGSTK–1180 Where applicable, the SDP Toolkit time system transformation tools shall return ASCII times that are in Consultative Committee for Space Data Systems (CCSDS) standard time code formats. CH01

Explanation**:** This only applies to those tools returning ASCII time formats.

PGSTK–1190 The SDP Toolkit time system transformation tools shall have the capability CH01

of returning TAI time in seconds from the start of a specified epoch.

PGSTK–1195 (Deleted) CH01

Explanation**:** Meaningless—Julian dates are always from 4713 BC. They are always in days and never in seconds.

PGSTK–1210 The SDP Toolkit shall assure that leap seconds are accounted for in all time and date conversion tools for binary formats, and leap days/years for ASCII formats. CH01

Note**:** The leap second information is based on USNO (U.S. Naval Observatory) but the interface is To Be Determined (TBD). CH01

5.3 PGS Toolkit Requirements—Science

5.3.1 Celestial Body Position and Coordinate Transformation Requirements

PGSTK–0680 Input to all relevant SDP Toolkit planetary body and spacecraft position access functions shall include spacecraft identification. CH01

PGSTK–0750 (Deleted) CH01

Explanation**:** Co–latitude is simply 90 degrees latitude which is an easy calculation for the user to perform. This requirement would excessively impact the toolkit by lengthening calling sequences. If an input flag were allowed to change the output, the user would have to supply same and remember what the output meant. Different meanings for the output of the same function are a poor design. If both were put in the calling list, the user would still have to supply a flag saying which to use. If both were put in the return list, the user would have to provide scratch space for returned arrays (most of our tools handle arrays of pixels at once).

PGSTK–0930 Geographic information access tools in the SDP Toolkit shall be capable of handling the north and south pole singularities, e.g., such a way that no failures, such as division by zero or erratic results in terms of positions will occur on approaching or passing over the poles. CH01

Explanation**:** It is difficult to put in a trick to increase resolution.

Note**:** The requirements above are general ones that apply to many of the tools in Section 6.3.1.

5.3.1.1 Celestial Body Position Access

PGSTK–0760 The SDP Toolkit shall contain tools that return local solar time for a given UTC time and position on the Earth's surface, as well as solar right ascension and declination. CH01

PGSTK–0860	(Deleted)	CH01
Explanation**:**	This is moved to Coordinate System Conversion (CSC) section.	
PGSTK–0770	(Deleted)	CH01
Explanation**:**	This is moved to CSC section.	
PGSTK–0900	The toolkit shall provide access to Greenwich Mean and Greenwich Apparent Sidereal Time.	CH01
Note**:**	Greenwich Mean Sidereal Time (GMST) is provided, but not as a users guide entry.	CH01
PGSTK–0780	The SDP Toolkit shall contain tools that return a flag for the presence of a celestial body in the field of view.	CH01
Explanation**:**	The word "disturbance" is vague.	
PGSTK–0820	The SDP Toolkit shall contain a tool that returns the nearest star or dark sky position to a provided vector.	CH01
Explanation**:**	This is only requested by SOLSTICE, a CHEM instrument.	
PGSTK–0800	The SDP Toolkit shall contain a tool that returns the Earth–Centered Inertial (ECI) vector from the Earth to the sun, moon, and planets at a given time.	CH01
PGSTK–0810	The SDP Toolkit shall contain a tool that returns the Satellite–Centered Inertial (SCI) vector from the Satellite to the sun, moon, and planets at a given time.	CH01

5.3.1.2 Coordinate System Conversion and Other Requirements

PGSTK–1050	The SDP Toolkit shall provide the following lower level coordinate system bi–directional transformations:		CH01
	a.	spacecraft reference to orbital reference	
	b.	Earth–Centered Inertial (ECI) to Earth–Centered Rotating (ECR)	
	c.	ECR to geodetic	CH01
	d.	ECI to spacecraft reference	
	e.	ECI to orbital reference	
Explanation:	b:	is a Geo–Coordinate Transformations function.	
	c:	assuming "earth reference ellipsoid" means geodetic coordinates; this requirement is met by using three delivered tools in sequence. There would be little or no computational savings if we were to put the same mathematics into one new tool.	

d: is a Geo–Coordinate Transformations function.

PGSTK–1080 The SDP Toolkit shall provide the latitude and longitude of the intersection of the earth reference ellipsoid with the instrument look vector in the spacecraft reference frame at an arbitrary time. CH01

PGSTK–1083 The SDP Toolkit shall provide a tool to geolocate every pixel (with its own look angle). CH01

PGSTK–1060 The SDP Toolkit shall provide the sub–satellite point and ground track velocity vector at any arbitrary time. CH01

PGSTK–1090 The SDP Toolkit shall provide a tool to determine a given point on earth is in an instrument field of view at any designated time. Parameters that determine instrument field–of–view relative to a platform are assumed to be supplied by instrument teams. CH01

Explanation**:** Previous wording is to broad—no time range or basis specified—this has been negotiated with the LIS team, which originally requested the tool.

PGSTK–1091 The SDP Toolkit shall provide the capability of determining the terrestrial zenith angle and azimuth of the look vector, as well as the vectors to any celestial body, at any specified latitude, longitude and altitude. CH01

Explanation:

a. The day/night tool PGSTK–0860 requires the solar zenith angle, so we had to write this tool anyway.

b. The requirement is implicit in PGSTK–1083.

c. Several users (Multi–Angle Imaging SpectroRadiometer (MISR), LIS,....) planned to build such a tool privately. In particular, LIS needs to look at specular reflections off bodies of water, and will need both azimuth and zenith angle for that purpose. Most users need illumination angle and want the angle of the look vector because terrain and foliage look different at different angles.

PGSTK–1092 The SDP Toolkit shall provide the capability of determining the angle of refraction of the look vector, other vectors at the look point and the displacement of the ray at the look point due to refraction, under mean atmospheric conditions. CH01

Explanation:

a. The solar incidence angle and look angle from zenith can be incorrect by a degree without this correction, and lookpoint locations can be off by typically 70 meters at 70 degrees and 1/2 km at 80 degrees zenith angle of the look vector.

b. MODIS, for example, has written separate software using a finite element method to calculate these effects. It would run very slowly and is much too detailed for what is needed—for example; it has

complicated atmospheric model built in. The Toolkit can easily implement analytic approximations now in house and tested to accomplish the same goal efficiently. Users such as MISR, MODIS and ASTER, wishing accurate registration of data taken at different look angles, will surely appreciate this functionality.

PGSTK–0860 The SDP Toolkit shall contain a tool to determine if a given point on the earth's surface is in day or in night.

PGSTK–0770 The SDP Toolkit shall contain tools that return Greenwich Hour Angle for a given time. CH01

PGSTK–0910 The SDP Toolkit shall provide a tool to transform a position and velocity vector between J2000 and true of date coordinate systems. CH01

PGSTK–0912 The SDP Toolkit shall provide a tool to transform a position and velocity vector between J2000 and mean of date coordinate systems. CH01

PGSTK–0914 The SDP Toolkit shall provide a tool to transform a position and velocity vector between mean of date and true of date coordinate systems. CH01

PGSTK–0916 The SDP Toolkit shall provide a tool to provide the angles of nutation in longitude and obliquity and their respective rates at a given time.

5.3.1.3 Geo–Coordinate Transformations

PGSTK–1500 The SDP toolkit shall support the bi–directional transformation between coordinates in the Cartesian ellipsoid reference frame and the Space Oblique Mercator, Universal Transverse Mercator, Polar Stereographic, and the Goodes Interrupted Homolosine Projections. CH01

PGSTK–1501 (Deleted) CH01

Explanation**:** This is included indirectly in PGSTK–1500.

PGSTK–1502 The SDP Toolkit geo–coordinate transformation tools shall support the transformation of multiple coordinate vectors in a single call. CH01

5.3.2 Math & Modeling Support

PGSTK–1245 The SDP Toolkit shall provide tools to accomplish various mathematical and
statistical tasks including, but not limited to: CH01

a. solution of linear algebraic equations, matrix manipulation, matrix inversion and Eigenvalue decomposition

b. interpolation and extrapolation

c. integration and evaluation of functions

d. root finding

e. determination of min/max of functions

f. statistical description of data

g. discrete Fourier Transforms and polynomial fits

CH01

Explanation**:** Cannot determine a need for (h).

5.3.3 Constants and Unit Conversions

5.3.3.1 Math, Physical and Instrument Constants

PGSTK–1520 The SDP Toolkit shall provide a means of accessing commonly used mathematical and physical constants. CH01

PGSTK–1521 The SDP Toolkit shall provide a means of accessing constant values related to an instrument. CH01

PGSTK–1522 The values of the parameters in PGSTK–1520 and PGSTK–1521 shall be capable of adjustment without recompilation of a PGE. CH01

5.3.3.2 Unit Conversions

PGSTK–1530 The SDP Toolkit shall provide a means to perform unit conversions and parameter translations. CH01

PGSTK–1531 (Deleted) CH01

Explanation**:** This requirement is considered unnecessary. The provision for conversions is provided under PGSTK–1530 and programmers may use this as a basis for their own transformations of multiple values.

5.3.4 Graphics Support

PGSTK–1410 The SDP Toolkit shall provide tools for producing graphics output from production software. CH01

PGSTK–1415 The SDP Toolkit shall provide tools for image processing; for map projections; correlations and registration; filters; contrast enhancement. CH01

Explanation**:** This is covered by PGSTK–1245.

Note**:** PGSTK–1415 is covered by EOSView, check data visualization CH01

requirements.

6. PGS Toolkit Specification (Deleted)

CH01

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7. Proposed PGS Toolkit Delivery Schedule (Deleted)

CH01

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Appendix A. Requirements Status and Tool Mapping

This Appendix is a mapping of the requirements in Section 4 of this document to their software implementation. A description of each tool referenced in this Appendix can be found in the SDP Toolkit Users Guide for the ECS Project, July 1995. The Appendix also contains a status for each requirement. The status indicates changes from the original Toolkit Specification (PGS Toolkit Requirements Specification for the ECS Project, Oct. 1993). A key for this status code is given in Table A–1. The requirements mapping is given in Table A–2. CH01

Table A–1. Requirement status code key:

Requirement	Implementation Status	Note
O – Original	C – Complete	G – Gov't requested
C – Clarified	P – Partial	C – Contractor initiated
A – Added	D – Deferred	S – Schedule prohibitive
D – Deleted	X – Incomplete	
S – Subsumed		

Table A–2. Tool Requirements Matrix (1 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0010	The interfaces provided by the SCF Toolkit functions to the science software shall either be identical to the interfaces provided by the SDP Toolkit functions to the science software, or they will be transparent emulations.	General requirement—met by all tools.	OC_
PGSTK–0020	Calling sequences of SCF Toolkit functions and SDP Toolkit functions shall be identical.	General requirement—met by all tools.	OC_
PGSTK–0040	Logical file paths referenced by SCF Toolkit functions and SDP Toolkit functions shall be identical, i.e., all file references shall be by logical file names.	Met by all I/O tools. Access to file paths is via process control table. Users Guide, Sec. 6.2.3	OC_
PGSTK–0050	The SCF Toolkit shall provide the capability to run a production process in the SCF test environment.	Use process control tools, shell programming, supported UNIX scripting languages. Users Guide, Sec. 6.2.3	OC_

Table A–2. Tool Requirements Matrix (2 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0060	The SCF Environment shall provide the capability for science software developers to generate a production script, capable of linking multiple PGEs into a single SCF command.	Use process control tools, shell programming, supported UNIX scripting languages. Users Guide, Sec. 6.2.3.	OC_
PGSTK–0080	The SCF Toolkit shall provide the capability to test all I/O transactions among PGEs that originate in the science software, in the same manner as the production environment.	PGS_IO_Gen_Open, Use process control tools, Users Guide, Sec. 6.2.3	OC_
PGSTK–0090	The SCF Toolkit shall contain error/status handling and reporting capabilities identical to those available in the SDP Toolkit.	General requirement—met by all tools.	OC_
PGSTK–0100	The SCF Toolkit shall contain versions that have been certified for each of the ECS approved computing platforms.	General requirement—met by all tools. List of platforms, operating sys. versions in Users Guide, Sec. 5. Separate versions are not maintained. A single version has been developed to comply with this requirement.	OC_
PGSTK–0101	The SCF Toolkit shall exhibit its portability and adaptability by producing the same results (to an agreed upon tolerance) on each of the approved computing platforms.	General requirement—met by all tools.	OC_
PGSTK–0120	The SCF Toolkit shall be POSIX compliant.	General requirement—met by all tools.	CC_
PGSTK–0121	The SDP Toolkit shall provide bindings to ECS approved languages.	General requirement—met by all tools.	CC_
PGSTK–0122	The SDP Toolkit shall be supported under the following Unix shells: Bourne, csh and Perl.	General requirement—met by all tools.	OC_
PGSTK–0123	SCF Toolkit source code shall be delivered to the SCFs.	General requirement—met by all tools.	OC_
PGSTK–0140	The SCF Toolkit shall provide access to Level 0 data provided by science software developers and/or ESDIS.	PGS_IO_L0_Open PGS_IO_L0_Close PGS_IO_L0_SetStart PGS_IO_L0_GetPacket PGS_IO_L0_GetHeader (SDPF format supported, complete implementation requires TBD EDOS formats)	OP_

PGSTK–0141	The SCF Toolkit shall provide access to simulated orbit data for at least 1 day and 1 night (15 consecutive orbits).	PGS_EPH_EphemAttit	OC_

Table A–2. Tool Requirements Matrix (3 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0160	The ECS contractor shall provide an Algorithm Integration Team at each DAAC, whose function shall be to answer questions about the SCF and SDP Toolkits, PDPS design and operations concept, and the science software integration and test process.	Algorithm Integration & Test (AI&T) Requirement. (This is an AITTL requirement, not a Toolkit software requirement).	D__
PGSTK–0170	A detailed user's guide for the SCF Toolkit shall be delivered, in both hardcopy and electronic versions, and shall include at a minimum detailed descriptions of the SDP Toolkit; all differences between the SCF and PDPS versions, both visible and invisible to Toolkit users, a set of sample production shell scripts; and sample makefiles, including switches for SCF/PDPS changes.	The SDP Toolkit Users Guide for the ECS Project, July, 1995.	CC_
PGSTK–0180	All SDP Toolkit functions shall return error/status codes that can be detected and reported using error/status reporting tools.	General requirement—met by all tools.	OC_
PGSTK–0190	The SDP Toolkit shall contain tools to open and close both SDPF and EDOS–generated Level 0 data sets.	PGS_IO_L0_Open PGS_IO_L0_Close (SDPF format supported, complete implementation requires TBD EDOS formats).	CP_
PGSTK–0200	The SDP Toolkit shall contain tools to read CCSDS–format packetized data from Level 0 data files. Data is assumed to be made available to the Toolkit in the native format of the computing platform the Toolkit is instantiated on.	PGS_IO_L0_SetStart. PGS_IO_L0_GetPacket.	CC_
PGSTK–0210	subsumed by PGSTK-0220, 0230		SC_
PGSTK–0220	The SDP Toolkit shall include the capability to access an arbitrary CCSDS packet within the staged data files, given the packet time stamp.	PGS_IO_L0_SetStart.	CC_
PGSTK–0230	The SDP Toolkit shall contain tools to access the metadata located within Level 0 data files, (i.e., SDPF– and EDOS– generated header, accounting and quality information).	PGS_IO_L0_GetHeader (SDPF format supported, complete implementation requires TBD EDOS formats).	CP_

Table A–2. Tool Requirements Matrix (4 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0235	The SDP Toolkit shall contain tools to access the ECS–internal metadata that is associated with the Level 0 data files provided to a PGE.	PGS_MET_GetPCAttr.	AC_
PGSTK–0240	The SDP Toolkit shall provide tools to access both SDPF– and EDOS–provided telemetry data.	This is met by all Level 0 tools (SDPF format supported, complete implementation requires TBD EDOS formats).	CP_
PGSTK–0270	The SDP Toolkit shall contain tools that select data items within an HDF file and read the selected data item, and optionally rewrite the HDF file with changes made to the data item.	Provided in NCSA HDF API. Additional functionality will be provided in HDF–EOS API.	CC_
PGSTK–0271	The SDP Toolkit shall contain tools that list the contents of HDF files, and verify that the files are legal HDF files.	Provided in NCSA HDF API. Additional functionality will be provided in HDF–EOS API.	CC_
PGSTK–0290	The SDP toolkit shall contain tools that read from and write to metadata information contained in HDF files.	PGS_MET_Init PGS_MET_SetAttr PGS_MET_GetSetAttr PGS_MET_GetPCAttr PGS_MET_GetConfigData PGS_MET_Write	CC_
PGSTK–0310	deleted	This is not a Toolkit requirement; it is covered by data server requirements.	D__
PGSTK–0320	subsumed by PGSTK-0321		SC_
PGSTK–0321	The SDP toolkit shall contain tools to read from and write to HDF files.	Provided in NCSA HDF API. Additional functionality will be provided in HDF–EOS API.	CC_
PGSTK–0322	deleted	This requirement is too general.	D_C
PGSTK–0323	deleted	RLE and JPEG compression provided for user choice.	D_C
PGSTK–0324	The SDP toolkit shall contain tools to convert a single instance of selected HDF datatypes into files in formats identified by the ESDIS project.	Conversion to ACSII and binary formats provided. In general it would be impossible to transfer the complex internal organization of HDF files completely into alternate formats.	CC_
PGSTK–0360	The SDP Toolkit shall contain tools to open and close generic files, including text and binary files. These generic files will be limited to those produced by an ECS approved language.	PGS_IO_Gen_Open PGS_IO_Gen_OpenF PGS_IO_Gen_Close PGS_IO_Gen_CloseF PGS_IO_Gen_OpenF90 PGS_IO_Gen_Track_Lun	CC_
PGSTK–0370	The SDP Toolkit shall support opening a metadata file.	PGS_MET_Init.	OC_

Table A–2. Tool Requirements Matrix (5 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0380	The SDP Toolkit shall be able to read information from and write information to a metadata file containing standard product and science–software–specific information. This software specific information will include program version number; institutional source; and other identifying information approved by the ECS Project	PGS_MET_WriteFile PGS_MET_GetPCAttr PGS_MET_GetConfigData PGS_MET_GetSetAttr	CC_
PGSTK–0390	subsumed by PGSTK-0400		SC_
PGSTK–0400	The SDP Toolkit shall be able to write a record of metadata in the metadata file using ECS standard structuring, and contain ECS standard, instrument specific and product specific attributes. The record will contain program variables and constants as well as values generated automatically (e.g., configuration information)	PGS_MET_Write	OC_
PGSTK–0410	The SDP Toolkit shall be able to overwrite a record in the temporary metadata store during PGE execution with a new record.	PGS_MET_SetAttr	CC_
PGSTK–0411	deleted	The SDP MET tools operate only within the PDPS environment. Adding new parameters to an existing record is a data server/inventory function.	D_C
PGSTK–0430	The SDP Toolkit shall support closing a metadata file.	PGS_MET_Remove	OC_
PGSTK–0440	subsumed by PGSTK-0400		SC_
PGSTK–0450	The SDP Toolkit shall support writing the ECS standard, instrument specific and product specific attributes into an ECS standard product file.	PGS_MET_Write	OC_
PGSTK–0510	The SDP Toolkit shall contain tools that support three types of Q/A data: (1) flags; (2) graphics files, which are output directly from science processes; and (3) data that is written in the same format as a standard product file.	PGS_MET_Write Interactive Data Language (IDL) graphics library HDF library	OC_
PGSTK–0520	The SDP Toolkit shall contain a tool for marking temporary files for deletion, enabling reuse of the logical file ID within science software.	PGS_IO_Gen_Temp_Delete	CC_

Table A–2. Tool Requirements Matrix (6 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0521	The SDP Toolkit shall contain a command tool for marking temporary files for deletion, enabling reuse of the logical file ID within the science software, while preserving the record of the defunct temporary file.	PGS_PC_TempDeleteCom	ACC
PGSTK–0530	The SDP Toolkit shall create temporary file names such that each name is unique for a given DAAC.	PGS_IO_Gen_Temp_Open PGS_IO_Gen_Temp_OpenF PGS_PC_GetTempRefCom PGS_PC_Gen_Temp_OpenF90	CC_
PGSTK–0531	SDP Toolkit shall contain a tool for creating "intermediate" files, whose longevity is determined by the user up to SDPS defined limits, e.g., a temporary calibration file may be retained as an intermediate file from the last orbit's processing or a file kept for averaging purposes for several months.	PGS_IO_Gen_Temp_Open PGS_IO_Gen_Temp_OpenF PGS_PC_GetTempReferenceCom PGS_PC_Gen_Temp_OpenF90	CC_
PGSTK–0532	deleted	This is a PDPS requirement.	D__
PGSTK–0533	subsumed by PGSTK–0531		S__
PGSTK–0534	subsumed by PGSTK–0531		S__
PGSTK–0535	The SDP Toolkit shall contain command tools for creating and retrieving intermediate and temporary file reference names at the level of the PGE's script.	PGS_PC_GetTempRefCom	AC_
PGSTK–0540	deleted	Deletion of temporary files is a PDPS function.	D__
PGSTK–0550	deleted	Generation of standard files names is a PDPS and a data server function.	D__
PGSTK–0570	The SDP Toolkit shall contain tools to monitor for the presence of the quicklook flag, which indicates that transmission to the SCF of part of the data from the spacecraft or from Level 1, is required.	Full definition of EDOS formats is required and are not availabel by TK5.	OD_
PGSTK–0580	The SDP Toolkit shall contain tools that can test for multi–level error/status conditions.	PGS_SMF_GetMsgByCode PGS_SMF_GetMsg.	CC_
PGSTK–0581	The SDP Toolkit shall provide an ordering for the multi–level error/status conditions thus enabling them to be used in conditional expressions.	smfcompile	AC_

Table A–2. Tool Requirements Matrix (7 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0582	The SDP Toolkit shall contain tools that allow the user to assert an error/status condition with a discrete severity level.	PGS_SMF_SetUNIXMsg PGS_SMF_SetHDFMsg PGS_SMF_SetStaticMsg PGS_SMF_SetDynamicMsg	AC_
PGSTK–0590	The SDP Toolkit shall support the following levels for error/status conditions: fatal error, general error, warning error, notice status, user–defined status, informational message status and success status.	PGS_SMF_TestErrorLevel PGS_SMF_TestFatalLevel PGS_SMF_TestMessageLevel PGS_SMF_TestWarningLevel PGS_SMF_TestUserInfoLevel PGS_SMF_TestSuccessLevel PGS_SMF_TestNoticeLevel PGS_SMF_TestStatusLevel smfcompile	CC_
PGSTK–0591	The SDP Toolkit shall provide the means of associating an action message with one or more status conditions.	PGS_SMF_GetActionByCode smfcompile	AC_
PGSTK–0600	The SDP Toolkit shall contain tools for recording user and Toolkit–defined error and status reports to log files.	PGS_SMF_SetUNIXMsg PGS_SMF_SetHDFMsg PGS_SMF_SetStaticMsg PGS_SMF_SetDynamicMsg PGS_SMF_GenerateStatusReport smfcompile	CC_
PGSTK–0610	The SDP Toolkit shall contain tools to uniquely identify the software unit, science software program, product and production run in error and status messages.	PGS_SMF_CreateMsgTag	OC_
PGSTK–0620	The SDP Toolkit shall contain tools to identify the associated instrument within the error message codes.	PGS_SMF_GetInstrName	OC_
PGSTK–0630	The SDP Toolkit shall provide a tool for marking all user requested files and status logs for subsequent retrieval by the SCF.	PGS_SMF_SendRuntimeData	CC_
PGSTK–0631	The SDP Toolkit shall support a tool for transferring all report and status logs to an intermediate location.	PGS_SMF_SendStatusReport	AC_
PGSTK–0632	The SDP Toolkit shall contain tools for integrating COTS status messages into the Toolkit wherever the Toolkit uses that COTS software.	PGS_SMF_SetUNIXMsg PGS_SMF_SetHDFMsg	AC_

Table A–2. Tool Requirements Matrix (8 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0650	The SDP Toolkit shall contain tools to associate with error messages at least the following: what routine noted the error, error–type, pertinent variable data, and action taken.	PGS_SMF_SetUNIXMsg PGS_SMF_SetHDFMsg PGS_SMF_SetStaticMsg PGS_SMF_SetDynamicMsg PGS_SMF_GetMsgByCode PGS_SMF_GetMsg PGS_SMF_GetActionByCode PGS_SMF_GetInstrName PGS_SMF_GenerateStatusReport smfcompile	OC_
PGSTK–0660	The SDP Toolkit shall contain tools to allow science algorithms to enable error trapping mechanisms for non–processing relating signals, and to issue the appropriate signal handling routines to respond to these events.	PGS_SMF_SetArithmeticTrap No POSIX compliant implementation is possible at time of TK5	OXC
PGSTK–0661	The SDP Toolkit shall be capable of performing context–sensitive buffering of status message information in order to provide an optimal level of efficiency.	Implemented through low–level tools—not in user API	AC_
PGSTK–0662	The SDP Toolkit shall prevent the proliferation of duplicate status messages from being recorded in the status log files.	Implemented through low–level tools—not in user API	AC_
PGSTK–0663	The SDP Toolkit shall provide the tools to enable and disable status messaging for user–specified calls.	PGS_SMF_Begin PGS_SMF_End	AC_
PGSTK–0664	The SDP Toolkit shall provide the tools to ensure that user status codes are unique across the entire ECS system.	smfcompile	AC_
PGSTK–0680	Input to all relevant SDP Toolkit planetary body and spacecraft position access functions shall include spacecraft identification.	PGS_CBP_Sat_CB_Vector and other tools in Users Guide, Sec. 6.3.2	OC_
PGSTK–0710	The SDP Toolkit shall use a single standard internal time in all ephemeris calculations.	Toolkit uses TAI as standard time, Users Guide, Sec. 6.2.7	OC_
PGSTK–0720	The SDP Toolkit shall provide tools to return spacecraft position, velocity, attitude, and quaternion defining the rotation from spacecraft to Earth Centered Inertial reference frame for any given time or for a range of times, including provision for interpolation between state vectors.	PGS_EPH_EphemAttit	CC_

Table A–2. Tool Requirements Matrix (9 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0730	subsumed	Level 0 req. This is mostly instrument specific engineering data access. General access provided is through Level 0 API. We do not have the definition of the engineering data stream at the time of Toolkit 5. We cannot implement this tool until we have the definition.	SD_
PGSTK–0740	The SDP Toolkit shall have the capability to provide to the user quality information about position and attitude.	PGS_EPH_EphemAttit We do not expect to have sufficient information to meet the original requirement. It may be almost impossible to actually have a user specify an accuracy and the toolkit guarantee that what is returned has that accuracy.	CP_
PGSTK–0750	deleted	Co–latitude is simply 90 degrees latitude which is an easy calculation for the user to perform. This requirement would excessively impact the toolkit by lengthening calling sequences. If an input flag were allowed to change the output, the user would have to supply same and remember what the output meant. Different meanings for the output of the same function are a poor design. If both were put in the calling list, the user would still have to supply a flag saying which to use. If both were put in the return list, the user would have to provide scratch space for returned arrays (most of our tools handle arrays of pixels at once).	D_C
PGSTK–0760	The SDP Toolkit shall contain tools that return local solar time for a given UTC time and position on the Earth's surface, as well as solar right ascension and declination.	PGS_CBP_SolarTimeCoords	CC_
PGSTK–0770	The SDP Toolkit shall contain tools that return Greenwich Hour Angle for a given time.	PGS_CSC_GreenwichHour	OC_
PGSTK–0780	The SDP Toolkit shall contain tools that return a flag for the presence of a celestial body in the field of view.	PGS_CBP_body_inFOV	CC_

Table A–2. Tool Requirements Matrix (10 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0800	The SDP Toolkit shall contain a tool that returns the Earth–Centered Inertial (ECI) vector from the Earth to the sun, moon, and planets at a given time.	PGS_CBP_Earth_CB_Vector	OC_
PGSTK–0810	The SDP Toolkit shall contain a tool that returns the Satellite–Centered Inertial (SCI) vector from the Satellite to the sun, moon, and planets at a given time.	PGS_CBP_Sat_CB_Vector	OC_
PGSTK–0820	TheSDP Toolkit shall contain a tool that returns the nearest star or dark sky position to a provided vector.	This is only requested by SOLSTICE, a CHEM instrument. It is defered to a later TK version.	CDC
PGSTK–0840	The SDP Toolkit shall provide a means to retrieve requested physical and geophysical parameters at specified locations from a selected data set. Data sets shall be those required by the ESDIS Project but will include as a minimum a DEM and a land–sea mask.	PGS_AA_2DGEO PGS_AA_3DGEO PGS_AA_DEM PGS_AA_DCW The toolkit does provide a means to retrieve geoid values where the geoid has been created in a raster binary format similar to that commonly used by DEMs. However, the geoid data set was deleted from this requirement since there is no such geoid data set available and creation of data sets is not covered by these requirements.	CC_
PGSTK–0850	The SDP Toolkit shall provide a means to retrieve regular grids or volumes of the required parameter defined by the upper left and bottom right vertices (x,y,z at each vertex).	PGS_AA_3DREAD The Toolkit supports this type of extraction by structure (x,y,z in cell number terms). The last part of the requirement is unclear. If it implies extraction by geographic coordinates then this is not supported (and is very undesirable to perform); otherwise it is a meaningless addendum.	CC_
PGSTK–0860	The SDP Toolkit shall contain a tool to determine if a given point on the earth's surface is in day or in night.	PGS_CSC_DayNight	OC_
PGSTK–0870	The SDP Toolkit shall contain tools to access a land/sea classification database including coastal outlines.	PGS_AA_DCW	OC_
PGSTK–0900	The toolkit shall provide access to Greenwich Mean and Greenwich Apparent Sidereal Time.	PGS_TD_gast	CC_

Table A–2. Tool Requirements Matrix (11 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0910	The SDP Toolkit shall provide a tool to transform a position and velocity between J2000 and true of date coordinate systems.	PGS_CSC_J200toTOD PGS_CSC_TODtoJ2000	AC_
PGSTK–0912	The SDP Toolkit shall provide a tool to transform a position and velocity vector between J2000 and mean of date coordinate systems.	PGS_CSC_precs2000	AC_
PGSTK–0914	The SDP Toolkit shall provide a tool to transform a position and velocity vector between mean of date and true of date coordinate systems.	PGS_CSC_nutate2000	AC_
PGSTK–0916	The SDP Toolkit shall provide a tool to provide the angles of nutation in longitude and obliquity and their respective rates of a given time.	PGS_CSC_wahr2	AC_
PGSTK–0930	Geographic information access tools in the SDP Toolkit shall be capable of handling the north and south pole singularities, e.g., in such a way that no failures, such as division by zero or erratic results in terms of positions will occur on approaching or passing over the poles.	PGS_CSC_ECRtoGEO PGS_CSC_GEOtoECR PGS_CSC_SubSatPoint PGS_CSC_GetFOV_Pixel PGS_CSC_DayNight	CC_
PGSTK–0931	The SDP Toolkit shall provide access to specified physical and geophysical datasets to retrieve single or multiple parameters and values from requested points, areas or volumes. This will include NMC six hour global model temperature, moisture and TOMS ozone profiles; NMC six hour global model surface parameters; and weekly SSM/I snow and ice data from NESDIS.	PGS_AA_2DGEO PGS_AA_3DGEO PGS_AA_2DRead PGS_AA_3DRead This requirement was updated following a review with EOS instrument team representatives on Jan. 31, 1995. The specific data sets are those commonly required (analysis from ECS SO). This requirement cannot be finally met until pre–processing software is in place and the HDF–EOS development is complete (including geo access tools). Current tools will provide this type of access provided pre–processing to simple binary is performed.	CP_

Table A–2. Tool Requirements Matrix (12 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–0980	The SDP Toolkit shall provide a means to retrieve elevation and terrain information from various terrain models at a specified latitude and longitude coordinate.	PGS_AA_DEM PGS_AA_2DRead PGS_AA_2DGEO There is no known DEM having slope and aspect as pre–generated parameters. Generation 'on–the–fly' is undesirable and requires commonly agreed interpolation rules that are not available at this time. This information can be derived from the DEM access tool (PGSTK–0840).	CC_
PGSTK–1000	The SDP Toolkit shall provide a means to receive from various terrain models a regular grid of elevation, from a rectangular area defined by the maximum extent of the rectangle.	PGS_AA_2DRead There is no known DEM having slope and aspect as pre–generated parameters. Generation 'on–the–fly' is undesirable and requires commonly agreed interpolation rules that are not available at this time.	CC_
PGSTK–1030	The SDP Toolkit shall provide the functionality to retrieve elevation and related information from DEMs (e.g. error terms, variability of elevation) as available.	PGS_AA_2DRead PGS_AA_2DGEO There is no known DEM having one–sigma parameters.	CC_
PGSTK–1040	deleted	This is single instrument specific (required by Moderate–Resolution Imaging Spectroradiometer (MODIS) only)	D_C
PGSTK–1050	The SDP Toolkit shall provide the following lower level coordinate system bi–directional transformations: a. spacecraft reference to orbital reference b. Earth–Centered Inertial (ECI) to Earth– Centered Rotating (ECR) c. ECR to geodetic d. ECI to spacecraft reference e. ECI to orbital reference	PGS_CSC_ECItoECR PGS_CSC_ECRtoECI PGS_CSC_ECRtoGEO PGS_CSC_GEOtoECR PGS_CSC_ECItoSC PGS_CSC_SCtoECI PGS_CSC_SCtoORB PGS_CSC_ORBtoSC PGS_CSC_ECItoORB PGS_CSC_ORBtoECI	CC_
PGSTK–1060	The SDP Toolkit shall provide the sub–satellite point and ground track velocity vector at any arbitrary time.	PGS_CSC_SubSatPoint	OC_

PGSTK–1070	deleted	The Toolkit could meet this requirement where both data sets were to be available in simple binary format. However, this is not known to be the case.	OC_

Table A–2. Tool Requirements Matrix (13 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1071	subsumed by 2D Tool requirements.	The generic 2D tools provided in the toolkit could be used to access such a data set if, a) one was available b), it was in simple binary format. However, neither of these is known to be true. In addition, the data set is required by a single instrument (MODIS).	SCC
PGSTK–1072	The SDP Toolkit shall provide tools to access images, where an API already exists access.	This is single instrument specific and could be covered by generic 2D tools and HDF tools.	CC_
PGSTK–1073	subsumed by PGSTK–0840	This is covered largely by land/sea tool (PGSTK–0840) while the 95% sea/ice part may or may not be realizable from National Environmental Satellite Data and Information Service (NESDIS) products. Sea ice products will be sought out from NESDIS but ECS cannot say what the percentile coverage is or develop special data sets to service this requirement.	SC_
PGSTK–1074	subsumed by PGSTK–0931		SC_
PGSTK–1075	deleted	This requirement is instrument specific from Lightening Imaging Sensor (LIS) and LIS no longer appears to require any ancillary data. LIS AHWGP v2.1/CDR Tech Baseline makes no reference for any use of tropopause model data in routine processing.Only required inputs for LIS are: Level 0 data (& ephemeris); LIS–team supplied ASCII file w/ parameters that set degree of processing at one step; LIS–team supplied calibration lookup table files.	D_C
PGSTK–1076	subsumed by PGSTK–0931	Single instrument specific	SP_
PGSTK–1077	subsumed by PGSTK–0931	Single instrument specific	SP_
PGSTK–1078	subsumed by PGSTK–0931	Single instrument specific	SP_

Table A–2. Tool Requirements Matrix (14 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1079	deleted	This requirement is from instruments not on the TRMM or EOS–AM platforms. In addition, the definition of a standard tidal algorithm is unlikely to be possible during 1995. We cannot, therefore, meet this requirement for TK5.	D_C
PGSTK–1080	The SDP Toolkit shall provide the latitude and longitude of the intersection of the earth reference ellipsoid with the instrument look vector in the spacecraft reference frame at an arbitrary time.	PGS_CSC_GetFOV_Pixel	OC_
PGSTK–1081	subsumed by PGSTK-0931		SC_
PGSTK–1082	subsumed by PGSTK-1081	ECS cannot guarantee period of data since it relies on ADC product operation.	SC_
PGSTK–1083	The SDP Toolkit shall provide a tool to geolocate every pixel (with its own look angle).	PGS_CSC_GetFOV_Pixel	OC_
PGSTK–1090	The SDP Toolkit shall provide a tool to determine whether a given point on earth is in an instrument field of view at any designated time. Parameters that determine instrument field–of–view relative to a platform are assumed to be supplied by instrument teams.	PGS_CSC_Earthpt_FOV	CC_
PGSTK–1091	The SDP Toolkit shall provide the capability of determining the terrestrial zenith angle and azimuth of the look vector, as well as the vectors to any celestial body, at any specified latitude, longitude and altitude.	PGS_CSC_ZenithAzimuth	ACC
PGSTK–1092	The SDP Toolkit shall provide the capability of determining the angle of refraction of the look vector, other vectors at the look point and the displacement of the ray at the look point due to refraction, under mean atmospheric conditions.	PGS_CSC_SpaceRefract	ACC

PGSTK–1160	The SDP Toolkit shall contain time system transformation tools that return UTC and TAI (International Atomic Time) times and Julian Dates that are of the same precision as the spacecraft clock.	General time tool requirement—met by all relevant time tools.	OC_

Table A–2. Tool Requirements Matrix (15 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1170	The SDP Toolkit shall provide tools to transform time among the six following systems: a. UTC (Julian Date and ASCII formats) b. UT1 (binary and Julian Date formats) c. TAI (binary and Julian Date formats d. Julian Date (floating point format, in units of days) e. spacecraft clock f. GPS	PGS_TD_UTCtoTAI PGS_TD_TAItoUTC PGS_TD_UTC_to_SCtime PGS_TD_SCtime_to_UTC PGS_TD_ASCIItime_AtoB PGS_TD_ASCIItime_BtoA PGS_TD_UTCtoGPS PGS_TD_GPStoUTC PGS_TD_UTCtoUT1 PGS_TD_UTCtoUT1jd PGS_TD_UTCtoUTCjd PGS_TD_UTCjdtoUTC PGS_TD_UTCtoTAIjd PGS_TD_TAIjdtoUTCjd	CC_
PGSTK–1180	Where applicable, the SDP Toolkit time system transformation tools shall return ASCII times that are in Consultative Committee for Space Data Systems (CCSDS) standard time code formats.	PGS_TD_ASCIItime_AtoB PGS_TD_ASCIItime_BtoA	CC_
PGSTK–1190	The SDP Toolkit time system transformation tools shall have the capability of returning TAI time in seconds from the start of a specified epoch.	PGS_TD_TimeInterval	OC_
PGSTK–1195	deleted	Requirement misworded; Julian dates are always from 4713 BC. They are always in days and never in seconds.	D_C
PGSTK–1210	The SDP Toolkit shall assure that leap seconds are accounted for in all time and date conversion tools for binary formats, and leap days/years for ASCII formats.	PGS_TD_UTCtoTAI PGS_TD_TAItoUTC PGS_TD_ASCIItime_AtoB PGS_TD_ASCIItime_BtoA PGS_TD_UTCtoGPS PGS_TD_GPStoUTC	OC_
PGSTK–1215	The SDP Toolkit shall contain tools to convert UTC to UT1 and ephemeris times.	PGS_TD_UTCtoUT1 PGS_TD_UTCtoUT1jd PGS_TD_UTCtoTDTjed PGS_TD_UTCtoTDBjed	CC_
PGSTK–1220	The SDP Toolkit shall contain provision to transform UTC and TAI to and from Julian Day formats, and to provide UT1 as a Julian Date, as well as a difference from UTC.	PGS_TD_UTCtoUTCjd PGS_TD_UTCtoTDIjd PGS_TD_UTCtoUT1jd PGS_TD_TAItoUTC PGS_TD_TBItoUTC PGS_CSC_UTC_UT1Pole	CC_

Table A–2. Tool Requirements Matrix (16 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1240	The SDP Toolkit shall provide tools which (1) dynamically allocate process–private memory (perhaps with limits) and (2) explicitly free dynamic memory within a program when it is no longer needed.	PGS_MEM_Malloc PGS_MEM_Realloc PGS_MEM_Zero PGS_MEM_Free PGS_MEM_FreeAll PGS_MEM_Calloc	CC_
PGSTK–1241	The SDP Toolkit shall provide tools which (1) allow a PGE to create a shared memory segment and (2) provide the means for applications within the PGE to access that shared memory segment for the duration of the PGE's execution.	PGS_MEM_ShmCreate PGS_MEM_ShmAttach PGS_MEM_ShmDetach PGS_MEM_Calloc	CC_
PGSTK–1245	The SDP Toolkit shall provide tools to accomplish various mathematical and statistical tasks including, but not limited to: a. solution of linear algebraic equations, matrix manipulation, matrix inversion and Eigenvalue decomposition b. interpolation and extrapolation c. integration and evaluation of functions d. root finding e. determination of min/max of functions f. statistical description of data g. discrete Fourier Transforms and polynomial fits	IMSL, commercial math/stat package provided	CC_
PGSTK–1251	subsumed	This is covered by HDF requirements.	SP_
PGSTK–1265	subsumed by PGSTK–1365	This requirement is partially covered by HDF requirements. Providing access to ASCII files provided by instrument teams is provided by the GEN_IO requirements. Providing access to specified parameters is only possible when ASCII PVL format is used	SC_
PGSTK–1280	The SDP Toolkit shall provide tools to generate product identifiers that can be used by the script/PGE to label metadata with environment and PGE information in order to facilitate production tracking.	PGS_PC_GenUniqueID	OC_

Table A–2. Tool Requirements Matrix (17 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1290	The SDP Toolkit shall provide tools to deliver runtime parameter data to the PGE. Examples of these parameters may include: executable mode values, availability of alternate data files, product output subset identification, filename references, number of staged versions, number of physical files associated with a file logical, and system defined directory paths for all PGE file inputs and outputs.	PGS_PC_GetReference PGS_PC_GetConfigData PGS_PC_GetNumberOfFiles PGS_PC_GetFileAttr PGS_PC_GetFileByAttr PGS_PC_GetReferenceCom PGS_PC_GetReferenceType	CC_
PGSTK–1291	The SDP Toolkit shall provide command tools to deliver runtime parameter data to the PGE's shell. Examples of these parameters may include: executable mode values, availability of alternate data files and system defined directory paths for temporary files.	PGS_PC_GetConfigDataCom PGS_PC_GetTempRefCom	AC_
PGSTK–1310	The SDP Toolkit shall provide tools for retrieving file metadata (also known as file attributes) that is associated with files staged by the PDPS.	PGS_PC_GetFileAttribute	CC_
PGSTK–1311	The SDP Toolkit shall provide tools for performing PGE initialization and termination procedures to support PGE usage of the Toolkit.	PGS_PC_InitCom PGS_PC_TermCom	AC_
PGSTK–1312	The SDP Toolkit shall provide a command tool to facilitate the execution of a PGE and its' initialization and termination.	PGS_PC_Shell.sh	AC_
PGSTK–1313	The SDP Toolkit shall provide a command tool to perform format checking on files containing Process Control Information.	pccheck	AC_
PGSTK–1314	The SDP Toolkit shall provide a command tool for retrieving file metadata that is associated with files staged by the PDPS.	PGS_PC_GetFileAttrCom	AC_
PGSTK–1315	The SDP Toolkit shall provide a command tool to retrieve the number of physical file instances that are associated with a single logical file instance.	PGS_PC_GetNumberofFilesCom	AC_

Table A–2. Tool Requirements Matrix (18 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1360	The SDP Toolkit shall provide access to ancillary data sets used by several instrument processing systems.	PGS_IO_Gen_Open PGS_AA_2DRead PGS_AA_3DRead PGS_AA_DCW	CC_
PGSTK–1361	subsumed		SC_
PGSTK–1362	The SDP Toolkit shall provide interfaces to access, retrieve and selectively manipulate ancillary data sets as required by the ESDIS Project.	PGS_AA_2DRead PGS_AA_3DRead PGS_AA_DCW PGS_AA_2DGEO PGS_AA_3DGEO	CC_
PGSTK–1363	subsumed by Level 0 tool requirements	This is instrument specific engineering data access. General access provided is through Level 0 API. We do not have the definition of the engineering data stream at the time of Toolkit 5. We cannot implement this tool until we have the definition.	SD_
PGSTK–1364	subsumed	Same explanation as PGSTK-1363	SD_
PGSTK–1365	The SDP toolkit shall provide an interface that accepts simple searches for parameter values on a PARAMETER=VALUE basis and returns parameter values.	PGS_AA_PeV_string PGS_AA_PeV_real PGS_AA_PeVA_string PGS_AA_PeVA_real	OC_
PGSTK–1366	subsumed	Same explanation as PGSTK-1363	SD_
PGSTK–1370	The PGS Toolkit shall provide an interface to perform simple linear interpolation in space between ancillary parameter points in geographically gridded data sets such as those in the NMC set.	Met by Math/Stat Library (PGSTK–1245	SCC
PGSTK–1410	The SDP Toolkit shall provide tools for producing graphics output from production software.	IDL commercial graphics package provided	OC_
PGSTK–1415	The SDP Toolkit shall provide tools for image processing; for map projections; correlations and registration; filters; contrast enhancement.	IDL commercial graphics package provided for general data formats. EOSView tool provides for HDF files.	CC_

PGSTK–1500	The SDP Toolkit shall support the bi–directional transformation between coordinates in the Cartesian ellipsoid reference frame and the Space Oblique Mercator, Universal Transverse Mercator, Polar Stereographic, and the Goodes Interrupted Homolosine Projections.	PGS_GCT_Init PGS_GCT_Proj	OC_

Table A–2. Tool Requirements Matrix (19 of 19)

Requirement Number	Description	Tools to Meet Requirement	Status Code
PGSTK–1501	subsumed by PGSTK–1500		SC_
PGSTK–1502	The SDP Toolkit geo–coordinate transformation tools shall support the transformation of multiple coordinate vectors in a single call.	PGS_GCT_Init PGS_GCT_Proj	OC_
PGSTK–1520	The SDP Toolkit shall provide a means of accessing commonly used mathematical and physical constants.	PGS_CUC_Cons PGS_CUC_Conv	OC_
PGSTK–1521	The SDP Toolkit shall provide a means of accessing constant values related to an instrument.	PGS_CUC_Cons PGS_CUC_Conv	OC_
PGSTK–1522	The values of the parameters in PGSTK–1520 and PGSTK–1521 shall be capable of adjustment without recompilation of a PGE.	PGS_CUC_Cons PGS_CUC_Conv	OC_
PGSTK–1530	The SDP Toolkit shall provide a means to perform unit conversions and parameter translations.	PGS_CUC_Cons PGS_CUC_Conv	OC_
PGSTK–1531	subsumed by PGSTK–1530		SC_
PGSTK–1600	The PGS Toolkit shall provide tools that perform bit and byte manipulation directly from applications developed in Fortran77.	Satisfied by most FORTRAN compilers complying with Mil–Std. Spec.	OC_

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Appendix B. Requirements Traceability Matrix

CH01

In this Appendix, we present a trace of the requirements listed in this document to their sources.

In Table A–1:

- “Section" and "Rqt #" refer to Sections 4 and 5 of this document.
- "L3 Rqt #" refers to the parent requirement from NAS5–60000, Attachment B, "Functional and Performance Requirements Specification for the EOSDIS Core System" [Level 3 requirements], dated 16 February 1993. In this column, “PGS–apdx” refers to Appendix C of NAS5–60000. “PGS–9999” refers to requirements for which no Level 3 requirement applies.
- "Doc #" refers to the source document. See Table 2 of this appendix.
- "Instr/Org" refers to the instrument team or organization that initiated the requirement. In this column, "JPL" refers to all JPL–based instrument teams, including Atmospheric Infrared Sounder (AIRS), Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), MISR, SeaWinds and NASA Scatterometer (NSCAT); “Derived” means the requirement was derived from Level 3 requirements by the ECS contractor.
- “Trace #” refers to the internal trace identification, assigned to all explicit potential requirements received from the science software teams.
- The table is sorted on requirement number. Duplicate PGSTK numbers correspond to the case where several requirements were combined into one.

Table B–1. Requirements Traceability Matrix (1 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number
4.2.1	PGSTK–0010	PGS–1030		Derived	
4.2.1	PGSTK–0020	PGS–1030		Derived	
4.2.1	PGSTK–0040	PGS–1030		Derived	
4.2.2	PGSTK–0050	PGS–1030	93–067	DPFT III	PGS–TR–073
4.2.2	PGSTK–0060	PGS–1030	93–068	DPFT II	PGS–TR–080
4.2.2	PGSTK–0080	PGS–1030	93–073	CERES	PGS–TR–116
4.2.2	PGSTK–0090	PGS–1030		Derived	
4.2.3	PGSTK–0100	PGS–1030		Derived	
4.2.3	PGSTK–0101	PGS–1030		Derived	

4.2	PGSTK–0120	PGS–0602		Derived	

Table B–1. Requirements Traceability Matrix (2 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number	
4.2	PGSTK–0121	PGS–0602		Derived		
4.2.3	PGSTK–0123	PGS–1030	93–066	JPL	PGS–TR–057	
4.2.4	PGSTK–0140	PGS–1030	93–023	JPL	PGS–TR–085	
4.2.4	PGSTK–0140	PGS–1030	93–073	MODIS	PGS–TR–112	
4.2.4	PGSTK–0141	PGS–1030	93–074	Geolocation	PGS–TR–103	
4.2.5	PGSTK–0160	PGS–1030		Derived		
4.2.5	PGSTK–0170	PGS–1030		Derived		
5.2	PGSTK–0180	PGS–1000	93–023	JPL	PGS–TR–095	
5.2	PGSTK–0180	PGS–1000		Derived		
5.2.1.1	PGSTK–0190	PGS–0435		Derived		
5.2.1.1	PGSTK–0200	PGS–0435		Derived		
						CH01
5.2.1.1	PGSTK–0220	PGS–0435	93–067	AIRS	PGS–TR–078	
5.2.1.1	PGSTK–0230	PGS–0435	93–076	MODIS	PGS–TR–167	
5.2.1.1	PGSTK–0240	PGS–0435	93–056	LIS	PGS–TR–011	
5.2.1.1	PGSTK–0235	PGS–0435		Derived		
5.2.1.2	PGSTK–0270	PGS–1010	93–023	JPL	PGS–TR–087	
5.2.1.2	PGSTK–0270	PGS–0970	93–078	MOPITT	PGS–TR–174	
5.2.1.2	PGSTK–0271	PGS–0970		Derived		
5.2.1.2	PGSTK–0290	PGS–0970	93–077	MODIS	PGS–TR–153	
5.2.1.2	PGSTK–0290	PGS–0970		Derived		
						CH01
						CH01
5.2.1.2	PGSTK–0321	PGS–0970		Derived		
						CH01
						CH01
5.2.1.2	PGSTK–0324	PGS–0970		Derived		
5.2.1.3	PGSTK–0360	PGS–1260	93–073	CERES	PGS–TR–124	
5.2.1.4	PGSTK–0370	PGS–0510		Derived		
5.2.1.4	PGSTK–0380	PGS–0510	93–065	AIRS	PGS–TR–035	
5.2.1.4	PGSTK–0380	PGS–0510		Derived		
						CH01
5.2.1.4	PGSTK–0400	PGS–0510		Derived		
5.2.1.4	PGSTK–0410	PGS–0510		Derived		
						CH01
5.2.1.4	PGSTK–0430	PGS–0510		Derived		
						CH01
5.2.1.4	PGSTK–0450	PGS–0510		Derived		

Table B–1. Requirements Traceability Matrix (3 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number	
5.2.1.5	PGSTK–0510	PGS–1050	93–068	DPFT II	PGS–TR–081	
5.2.1.5	PGSTK–0510	PGS–1100	93–073	MODIS	PGS–TR–141	
5.2.1.5	PGSTK–0510	PGS–1025	93–077	MODIS	PGS–TR–148	
5.2.1.5	PGSTK–0510	PGS–1025	93–077	MODIS	PGS–TR–152	
5.2.1.6	PGSTK–0520	PGS–1315	93–064	ASTER	PGS–TR–027	
5.2.1.6	PGSTK–0520	PGS–1010		Derived		
5.2.1.6	PGSTK–0521	PGS–1010		ASTER		
5.2.1.6	PGSTK–0530	PGS–1010		Derived		
5.2.1.6	PGSTK–0531	PGS–1010	93–073	CERES	PGS–TR–129	
						CH01
						CH01
						CH01
						CH01
5.2.1.6	PGSTK–0535	PGS–1010		ASTER		
						CH01
						CH01
						CH01
						CH01
5.2.1.7	PGSTK–0570	PGS–0530		Derived		
5.2.2	PGSTK–0580	PGS–1000	93–065	AIRS	PGS–TR–034	
5.2.2	PGSTK–0580	PGS–0990		Derived		
5.2.2	PGSTK–0581	PGS–0990		Derived		
5.2.2	PGSTK–0582	PGS–0990		Derived		
5.2.2	PGSTK–0590	PGS–1000	93–064	ASTER	PGS–TR–026	
5.2.2	PGSTK–0590	PGS–1000	93–064	ASTER	PGS–TR–032	
5.2.2	PGSTK–0590	PGS–1000		Derived		
5.2.2	PGSTK–0591	PGS–1000		Derived		
5.2.2	PGSTK–0600	PGS–0990		Derived		
5.2.2	PGSTK–0610	PGS–1000		Derived		
5.2.2	PGSTK–0620	PGS–1000	93–067	DPFT III	PGS–TR–074	
5.2.2	PGSTK–0630	PGS–1000	93–064	ASTER	PGS–TR–028	
5.2.2	PGSTK–0631	PGS–1000		Derived		
5.2.2	PGSTK–0632	PGS–1000		Derived		
5.2.2	PGSTK–0650	PGS–1000	93–065	AIRS	PGS–TR–039	
5.2.2	PGSTK–0660	PGS–1000		Derived		
5.2.2	PGSTK–0661	PGS–1000		ASTER		
5.2.2	PGSTK–0662	PGS–1000		ASTER		
5.2.2	PGSTK–0663	PGS–1000		ASTER		

Table B–1. Requirements Traceability Matrix (4 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number	
5.2.2	PGSTK–0664	PGS–1000		ASTER		
5.3.1	PGSTK–0680	PGS–1015	93–073	CERES	PGS–TR–118	
5.2.7	PGSTK–0680	PGS–0520		Derived		
5.2.7	PGSTK–0710	PGS–1015	93–066	JPL	PGS–TR–044	
5.2.7	PGSTK–0720	PGS–1015		Derived		
						CH01
5.2.7	PGSTK–0740	PGS–1015	93–079	JPL	PGS–TR–156	
						CH01
5.3.1.1	PGSTK–0760	PGS–1015		Derived		
5.3.1.1	PGSTK–0770	PGS–1015		Derived		
5.3.1.1	PGSTK–0780	PGS–1015	93–066	JPL	PGS–TR–046	
5.3.1.1	PGSTK–0800	PGS–1015	93–066	JPL	PGS–TR–047	
5.3.1.1	PGSTK–0800	PGS–1015	93–073	MODIS	PGS–TR–132	
5.3.1.1	PGSTK–0810	PGS–1015	93–073	MODIS	PGS–TR–133	
5.3.1.1	PGSTK–0820	PGS–1015	93–073	MODIS	PGS–TR–134	
5.2.6.3	PGSTK–0840	PGS–0490	93–064	ASTER	PGS–TR–031	
5.2.6.3	PGSTK–0840	PGS–0490	93–065	AIRS	PGS–TR–038	
5.2.6.3	PGSTK–0840	PGS–0490	93–067	DPFT III	PGS–TR–062	
5.2.6.3	PGSTK–0840	PGS–0490	93–073	Geolocation	PGS–TR–109	
5.2.6.3	PGSTK–0840	PGS–0490		Derived		
5.2.6.3	PGSTK–0850	PGS–0490		Derived		
5.3.1.1	PGSTK–0860	PGS–1015	93–056	LIS	PGS–TR–006	
5.2.6.3	PGSTK–0870	PGS–0490	93–056	LIS	PGS–TR–007	
5.2.6.3	PGSTK–0870	PGS–1015	93–023	JPL	PGS–TR–090	
5.3.1.1	PGSTK–0900	PGS–1015	93–073	Geolocation	PGS–TR–106	
5.3.1.2	PGSTK–0910	PGS–1015		CERES		
5.3.1.2	PGSTK–0912	PGS–1015		CERES		
5.3.1.2	PGSTK–0914	PGS–1015		CERES		
5.3.1.2	PGSTK–0916	PGS–1015		CERES		
5.3.1	PGSTK–0930	PGS–1015	93–073	MODIS	PGS–TR–135	
5.2.6.4	PGSTK–0931	PGS–0520		Derived		
5.2.6.3	PGSTK–0980	PGS–0490		Derived		
5.2.6.3	PGSTK–1000	PGS–0490		Derived		
5.2.6.3	PGSTK–1030	PGS–0490	93–066	JPL	PGS–TR–050	
5.2.6.3	PGSTK–1030	PGS–0490	93–076	MODIS	PGS–TR–169	
						CH01
5.3.1.2	PGSTK–1050	PGS–1015	93–063	LIS	PGS–TR–017	
5.3.1.2	PGSTK–1050	PGS–1015		Derived		

Table B–1. Requirements Traceability Matrix (5 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number	
5.3.1.2	PGSTK–1060	PGS–1015	93–078	MOPITT	PGS–TR–146	
						CH01
						CH01
5.2.6.3	PGSTK–1072	PGS–0490	93–023	JPL	PGS–TR–091	
						CH01
						CH01
						CH01
						CH01
						CH01
						CH01
						CH01
5.3.1.2	PGSTK–1080	PGS–1015		Derived		
						CH01
						CH01
5.3.1.2	PGSTK–1083	PGS–1015	93–090	LIS	PGS–TR–175	
5.3.1.2	PGSTK–1090	PGS–1015	93–063	LIS	PGS–TR–015	
5.3.1.2	PGSTK–1091	PGS_1015		LIS		
5.3.1.2	PGSTK–1092	PGS–1015		LIS		
5.2.8	PGSTK–1160	PGS–0435	93–056	LIS	PGS–TR–008	
5.2.8	PGSTK–1160	PGS–0435	93–066	JPL	PGS–TR–052	
5.2.8	PGSTK–1160	PGS–0435	93–073	CERES	PGS–TR–119	
5.2.8	PGSTK–1160	PGS–0435	93–073	MODIS	PGS–TR–140	
5.2.8	PGSTK–1160	PGS–0435	93–079	JPL	PGS–TR–155	
5.2.8	PGSTK–1170	PGS–0435	93–063	LIS	PGS–TR–019	
5.2.8	PGSTK–1170	PGS–0435	93–063	LIS	PGS–TR–022	
5.2.8	PGSTK–1170	PGS–0435	93–066	JPL	PGS–TR–051	
5.2.8	PGSTK–1180	PGS–0435	93–063	LIS	PGS–TR–020	
5.2.8	PGSTK–1190	PGS–0435	93–063	LIS	PGS–TR–021	
						CH01
5.2.8	PGSTK–1210	PGS–0435	93–073	CERES	PGS–TR–120	
5.2.8	PGSTK–1215	PGS–0435		Derived		
5.2.8	PGSTK–1220	PGS–0435	93–073	CERES	PGS–TR–126	
5.2.8	PGSTK–1220	PGS–0435	93–079	JPL	PGS–TR–154	
5.2.4	PGSTK–1240	PGS–9999		Derived		
5.2.4	PGSTK–1241	PGS–9999		Derived		
5.3.2	PGSTK–1245	PGS–1020	93–056	LIS	PGS–TR–009	
5.3.2	PGSTK–1245	PGS–1020	93–067	DPFT III	PGS–TR–053	
5.3.2	PGSTK–1245	PGS–1020	93–067	DPFT III	PGS–TR–061	

Table B–1. Requirements Traceability Matrix (6 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number	
5.3.2	PGSTK–1245	PGS–1020	93–066	JPL	PGS–TR–100	
5.3.2	PGSTK–1245	PGS–1020	93–073	DPFT III	PGS–TR–114	
						CH01
						CH01
5.2.6.2	PGSTK–1265	PGS–1015		Derived		
5.2.3	PGSTK–1280	PGS–0510		Derived		
5.2.3	PGSTK–1290	PGS–0980	93–073	CERES	PGS–TR–128	
5.2.3	PGSTK–1290	PGS–0980	93–077	MODIS	PGS–TR–151	
5.2.3	PGSTK–1291	PGS–0980		ASTER,MODIS		
5.2.3	PGSTK–1310	PGS–0980	93–077	MODIS	PGS–TR–150	
5.2.3	PGSTK–1311	PGS–0980		ASTER		
5.2.3	PGSTK–1312	PGS–0980		ASTER		
5.2.3	PGSTK–1313	PGS–0980		ASTER		
5.2.3	PGSTK–1314	PGS–0980		ASTER		
5.2.3	PGSTK–1315	PGS–0980		ASTER		
5.2.6	PGSTK–1360	PGS–1015		Derived		
						CH01
5.2.6	PGSTK–1362	PGS–0510		Derived		
						CH01
						CH01
5.2.6.2	PGSTK–1365	PGS–1015		Derived		
						CH01
						CH01
5.3.4	PGSTK–1410	PGS–1025	93–067	DPFT III	PGS–TR–060	
5.3.4	PGSTK–1410	PGS–1025	93–078	MOPITT	PGS–TR–143	
5.3.4	PGSTK–1415	PGS–1025	93–067	DPFT III	PGS–TR–070	
5.3.4	PGSTK–1415	PGS–1025	93–023	JPL	PGS–TR–086	
5.3.4	PGSTK–1415	PGS–1025	93–023	JPL	PGS–TR–092	
5.3.4	PGSTK–1415	PGS–1025	93–023	JPL	PGS–TR–098	
5.3.1.3	PGSTK–1500	PGS–1015	93–067	DPFT III	PGS–TR–065	
5.3.1.3	PGSTK–1500	PGS–1015	93–073	Geolocation	PGS–TR–108	
5.3.1.3	PGSTK–1500	PGS–1015		Derived		
						CH01
5.3.1.3	PGSTK–1501	PGS–1015		Derived		
5.3.1.3	PGSTK–1502	PGS–1015		Derived		
5.3.3.1	PGSTK–1520	PGS–1025		Derived		
5.3.3.1	PGSTK–1521	PGS–0458		Derived		

5.3.3.1	PGSTK–1522	PGS–1020		Derived	

Table B–1. Requirements Traceability Matrix (7 of 7)

Section	Requirement Number	L3 Rqmt Number	Doc Number	Instr/Org	Trace Number
5.3.3.2	PGSTK–1530	PGS–1020	93–056	LIS	PGS–TR–005
5.3.3.2	PGSTK–1530	PGS–1020	93–023	JPL	PGS–TR–097
5.3.3.2	PGSTK–1530	PGS–1020		Derived	
					CH01
5.2.5	PGSTK–1600	PGS–0520		Derived	

Table B–2 Source Documents

Doc Number	Name
93–023	Response to NASA PGS Toolkit Study, JPL (MISR/AIRS/ASTER), 11/92
93–055	Preliminary Draft: ECS PGS Toolkit Requirement Specification, 6/29/93
93–056	Comments on Prelim Draft PGS Toolkit Rqts Spec, LIS Team , 7/6/93
93–063	Private Communication: Steve Goodman/LIS, 7/16/93
93–064	ASTER Product Generation System Concept, 6/10/93
93–065	PGS Operations Concept for the AIRS Instrument, V1.0.2, 5/7/93
93–066	Response to Preliminary Draft of PGS Toolkit Rqt Spec by JPL, 7/13/93
93–067	DPFT III notes – Hughes Internal, 6/23/93
93–068	Minutes: 2nd Data Processing Focus Team mtg (DPFT II), 3/11/93
93–073	Hughes Trip Notes: CERES 7/22/93 Geolocation Meeting – Hughes Internal 6/9/93 MODIS 6/8/93 AIRS 5/25/93 DPFT III NASA/GSFC (T.Meyer, Coord.) 6/23/93 MODIS Level 1A SRR (MODIS SDST) 5/11/93
93–074	Geolocation Meeting Slides and Handouts – 6/9/93
93–076	MODIS Comments on Prelim Draft PGS Toolkit Rqts Spec, 7/26/93
93–077	MODIS Data Processing Operations Concept Draft, 7/13/93
93–078	S.Scott (NASA/GSFC) private communication, MOPITT trip notes, 7/15/93 MOPITT comments on Prelim Draft PGS Toolkit Rqts Spec 7/15/93
93–079	Comments on Prelim Draft PGS Toolkit Rqts Spec, J.Brown, SeaWinds/JPL, 7/13/93
93–090	Comments on V3.1 PGS Toolkit Rqts Spec, LIS, 10/18/93

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Appendix C. Open Issues

CH01

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Appendix D. Disposition of Unused Requirements.

CH01

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Abbreviations and Acronyms

AIT	Algorithm Integration Team
API	Application Program Interface
ADC	Affiliated Data Center
AIRS	Atmospheric Infrared Sounder
AMSU	Advanced Microwave Sounding Unit
ASTER	Advanced Space borne Thermal Emission and Reflection Radiometer
CASE	Computer Aided Software Engineering
CCSDS	Consultative Committee on Space Data Systems
CDOS	Customer Data and Operations System
CERES	Clouds and Earth Radiant Energy System
COTS	Commercial Off-The-Shelf (Hardware or software)
CPU	Central Processing Unit
CSMS	Communications and Systems Management Segment (ECS)
DAO	Data Assimilation Office
DBMS	Data Base Management System
DCE	Distributed Computing Environment
DEM	Digital Elevation Model
DID	Data Item Description
DMSP	Defense Meteorological Satellite Program
DPFT	Data Processing Focus Team
DTM	Digital Terrain Model
ECI	Earth Centered Inertial
ECMWF	European Centre for Medium Range Weather Forecasting
ECR	Earth Centered Rotating
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System

EOC	Earth Observation Center (Japan); EOS Operations Center (ECS)
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EOSP	Earth Observing Scanning Polarimeter
ESDIS	Earth Science Data and Information System
ESN	EOS Science Network
FDF	Flight Dynamics Facility
GCTP	Geo-Coordinate Transformation Package
GOMR	Global Ozone MonitoRing Instrument (NOAA)
GSFC	Goddard Space Flight Center
HITC	Hughes Information Technology Corporation
HDF	Hierarchical Data Format
I/O	Input/Output
ICC	Instrument Control Center (ECS)
IEEE	Institute of Electrical and Electronic Engineers
IMS	Information Management System (ECS)
IP	International Partner
IWG	Investigator Working Group
JPL	Jet Propulsion Laboratory
LIS	Lightning Imaging System
L0-L4	Level 0 through Level 4 (processing)
MIMR	Multi-Frequency Imaging Microwave Radiometer
MISR	Multi-Angle Imaging Spectro-Radiometer
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOPITT	Measurements of Pollution in the Troposphere
MTPE	Mission to Planet Earth
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputer Applications
netCDF	network Common Data Format

NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NSCAT	NASA Scatterometer
ODC	Other Data Center
PGE	Product Generation Executive (formerly Product Generation Executable)
PGS	Product Generation System (ECS)
PGSTK	Product Generation System Toolkit
POSIX	Portable Operating System Interface for Computer Environments
QA	Quality Assurance
SCF	Science Computing Facility
SES	Scheduling and Execution Subsystem
SDPS	Science Data Processing Segment
SDSC	San Diego Supercomputing Center
SGI	Silicon Graphics International
SOM	Space Oblique Mercator
SMC	System Management Center (ECS)
SRR	System Requirements Review
TBD	To Be Determined
TDRSS	Tracking and Data Relay Satellite System
TRMM	Tropical Rainfall Measuring Mission (joint US - Japan)
UARS	Upper Atmosphere Research Satellite
USGS	United States Geodetic Survey
USNO	U.S. Naval Observatory
UTC	Universal Time Coordinate
XPG	Xopen Portability Group

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Glossary

ALGORITHMS (Science Software) consist of the executable programs for science product generation, source code of these executable programs, job control scripts, and algorithm documentation. Algorithms are the result of a new or updated science algorithm passing through the integration and test process, involving the scientist and the PGS's algorithm integration and test staff. After formal approval, algorithms are delivered by the PGS to the DADS for storage, and are retrieved as needed to support product generation production. Some frequently used algorithms may be kept on line in the PGS.

ALGORITHMS UPDATES are delivered to the PGS's integration and test environment by scientists at an SCF. They represent changes to existing production algorithms, or a new algorithm to produce a new Standard Product. Algorithm updates include the source code for the candidate algorithm, its associated documentation, and a job step control skeleton. The source code will be compiled to form an executable program suite as part of the integration and test process. The job step control skeleton contains instructions that control the sequence of execution of, and the interchange of data between programs fro the executable program suite. Test data sets and calibration data should also be included.

ANCILLARY DATA refers to any data, other than Standard Products, that are required as input in the generation of a Standard Product. This may include selected engineering data from the EOS platform, as well as non-EOS ancillary data. All ancillary data is received by the PGS from the DADS.

AUXILIARY DATA Auxiliary data can be any data set which enhances the processing or utilization of satellite remote sensing instrument data. The auxiliary data is not captured by the same data collection process as the instrument data. Auxiliary data sets can include data collected by any platform or process, preferably in georeferenced digital format (CEOS).

CALIBRATION is the collection of data required to perform calibration of the instrument science data, instrument engineering data, and the spacecraft or platform engineering data. It includes preflight calibration measurements, in-flight calibrator measurements, calibration equation coefficients derived from calibration software routines, and ground truth data that are to be used in the data calibration processing routine.

DATA AVAILABILITY SCHEDULE is a schedule indicating the times at which specific data sets will be available form remote DADS, EDOS, the IPs, the ADCs and ODCs for ingestion by the collocated DADS. The schedules are received directly by the PGS.

DATA PRODUCTS consist of Level 0 data or Level 1 through Level 4 data products obtained by the PGS from the collocated DADs. These represent the primary input to the product generation process.

DATA QUALITY REQUEST is a request issued by the PGS to a scientist at an SCF to perform QA of a particular product before future processing or distribution. A time window is applied to the request in keeping with the production schedule.

DIRECTIVES consist of information received by the PGS from the SMC that acts as a final authoritative directive for action. It may include general policies, official procedures, and resolutions of schedule conflicts that have not been resolved with the IMS.

DYNAMIC DATA SETS are those containing parameters whose values change routinely and predictability; i.e. at set intervals in time.

L0 PRODUCTION DATA is the result of L0 processing by EDOS on the raw science and engineering data from the EOS platform. It is data that is time-ordered, with overlaps removed.

L0-L4 DATA PRODUCTS consist of L0 Data Products from IPs, the ADCs and ODCs, and L1-L4 Standard Products produced in the PGS.

METADATA is data which describes a Standard Product including standard metadata (i.e., algorithm and calibration number, size of product, date created, etc.), algorithm-derived metadata, QA information from the PI's, summary statistics and an audit trail.

ON TIME QA is a response to a data quality request that is received within the established production time window. It is received from a scientist at an SCF. It consists of data which will be used to complete the QA fields of the metadata. Overdue QA responses are sent directly to the DADS.

PRODUCT COORDINATION is the coordination of the receipt, staging, and storage of data necessary to carry out the PGS processing schedule.

PRODUCT GENERATION EXECUTABLE is an obsolete term. See PRODUCT GENERATION EXECUTIVE

PRODUCT ORDER is either a request for the generation of a specific product with an associated time window, a priority processing request, a reprocessing request, or a standing order for a product to be generated on a regular basis with a rough timeline, or changes to standing orders. Product orders are received by the PGS from the IMS.

PRODUCT STATUS DIALOG consists of information to assist the IMS in tracking the status of a product order. The IMS may send to the PGS a request for the status of a product to which the PGS would respond with the current product status. The PGS will send a schedule conflict notice to the IMS if a product request will cause a schedule conflict and the IMS may respond with an adjustment to the time window. Schedule conflicts not resolved at this level are resolved by the SMC. The PGS will send an overdue alert to the IMS if it is clear that a product order will not be met on time.

QUICK LOOK DATA are data received during one TDRSS contact period which have been processed to Level 0 (to the extent possible for data from a single contact). These are data that have been identified as requiring priority processing on the order of a few hours. They are routed to the PGS from the DADS.

QUICK LOOK PRODUCTS are the result of applying science algorithms to quick-look data. These products are expeditiously sent over to the DADS, which directly routes them to the appropriate ICC and field campaign users.

STANDARD PRODUCTS are data products that are routinely produced and identified as normal project deliverables.

STATIC DATA SETS are those containing parameters whose values may change, but not routinely at set intervals in time.

STATUS is information regarding schedules, hardware and software configuration, exception conditions, or processing performance. This information is exchanged with the DADS, and is provided to the SMC. The SMC may also receive information regarding schedule conflicts that have not been resolved with the IMS.

SCHEDULES represent the current sequence of tasks to be executed along with approximate execution times as generated by the PGS scheduler. Copies of these schedules, which are updated frequently, are made available to the IMS, the SMC, and the DADS.

TEST PRODUCTS are science products generated by new or updated algorithms during the integration and test period. Test products are delivered to scientists at an SCF.

TEMPORARY FILE is a file which may exists for the duration of a single PGE, or may exist for some indeterminate time beyond the termination of the PGE which created it.

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